California Air Resources Board

$PM_{2.5}$ AND PM_{10} NATURAL EVENT DOCUMENT

SOUTHERN CALIFORNIA HIGH WINDS AND WILDFIRES
OCTOBER/NOVEMBER 2007

Table of Contents **Page**

Exceptional Event Affected Air Quality

On October 20, 2007, the first of numerous wildfires in Southern California was reported in Los Angeles County. Over the next few days, additional fires were reported in Los Angeles, Orange, Ventura, Riverside, San Bernardino, and San Diego Counties. Strong Santa Ana winds, which also entrained and transported dust and ash, exacerbated the impact of these fires. Numerous monitoring sites, comprising both Federal Reference Method (FRM) and Federal Equivalent Method (FEM) monitors, recorded almost daily elevated particulate matter (PM) concentration levels, with many days above the National Ambient Air Quality Standards (NAAQS) for both $PM_{2.5}$ and PM_{10}.

Several Air Districts reported exceedances of the PM NAAQS high enough to adversely affect the 24-hour and annual average design values. ARB is requesting exclusion of data from 14 FRM and FEM monitoring sites in five Air Districts, as noted in Table 1, shown in Figure 1, and detailed in Appendix A. Many other monitors, both FRM/FEM and non-FRM/FEM were affected, but the data did not meet the strict criteria listed below.

Three basic criteria were used to identify data to be included in this request.

1. **Location**: Monitoring sites were located in the affected area of Southern California. This included sites in the Mojave Desert Air Basin, the South Coast Air Basin, the South Central Coast Air Basin, and the San Diego Air Basin.

2. **Time Frame**: The days impacted by smoke and high winds were within the time frame of the October high wind events and the Southern California wildfires. High winds, accompanying a strong cold front, buffeted the region in the afternoon of October 20, the same day the first of the wildfires was ignited. Santa Ana winds, which began in earnest the next day, October 21, lasted until October 24. The majority of the fires had been contained by November 1, with the last, the Poomacha Fire in San Diego County, contained on November 13. Fire containment, however, does not mean that the fire has been extinguished. Smoke effects may still be present far beyond the containment date.

3. **Impact on Air Quality**: Concentration levels had to exceed the 24-hour NAAQS for $PM_{2.5}$ (35.5 $\mu g/m^3$) or PM_{10} (150 $\mu g/m^3$) and had to be historically significant. In addition, concentration levels that were 10 $\mu g/m^3$ or greater than the site's $PM_{2.5}$ seasonal (September/October/November) 98^{th} percentile, indicating a smoke or dust/ash contribution of at least 10 $\mu g/m^3$, were also considered. Many monitoring sites that were affected by the wildfires and/or the high winds were not included in this request if the contribution was determined to be below this historical/seasonal lower limit.

Table 1. PM Monitoring Sites Requested for Exclusion

DISTRICT	SITE_NAME	AIRS ID	Exclusion Requested	
			$PM_{2.5}$	PM_{10}
Mojave Desert AQMD	Victorville – Park	060710306		10/20/07
San Diego County APCD	Chula Vista	060730001	10/24/07	
	Escondido – E Valley	060731002	10/22/07 10/23/07 10/28/07	
	Otay Mesa	060732007		10/21/07
	Otay Mesa – RCF	060731014		10/22/07
	San Diego – Beardsley	060731010	10/23/07 10/24/07 10/25/07	
Santa Barbara County APCD	El Capitan Beach	060830008		10/21/07
	Las Flores Canyon (Capitan)	060831025		10/21/07
South Coast AQMD	Anaheim-Pampas	060590007		10/21/07*
	Fontana	060712002		10/21/07*
	Mission Viejo	060592022	11/2/07 11/5/07	
	North Long Beach	060374002		10/21/07*
	Norco	060650003		10/21/07*
	Ontario	060710025		10/21/07*
	Perris	060656001		10/21/07*
	Riverside - Rubidoux	060658001		10/21/07*
	San Bernardino – 4th	060719004	10/24/07	10/21/07*
	Santa Clarita	060376012		10/21/07*
Ventura County APCD	El Rio – School #2	061113001	10/21/07	10/21/07

** A request to exclude these data as impacted by an exceptional event has already been forwarded to the U.S. EPA[1].*

Figure 1. Wildfire Perimeters and Particulate Matter Monitoring Sites Requested for Exclusion
[http://www.fs.fed.us/r5/rsl/clearinghouse/data.shtml]

Regulatory Background

The Code of Federal Regulations (40 CFR 50.1)[2] provides the definition and criteria for determining whether air quality data is impacted by an exceptional event. The definition (40 CFR 50.1 (j)) states that "exceptional event means an event that affects air quality, is not reasonably controllable or preventable, is an event caused by human activity that is unlikely to recur at a particular location *or a natural event*, and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event." The demonstration to justify data exclusion as outlined in 40 CFR 50.14 specifies that evidence must be provided that:

- The event meets the definition of an exceptional event;
- There is a clear causal relationship between the measurement under consideration and the event that is claimed to have affected air quality in the area;
- The event is associated with a measured concentration in excess of normal historical fluctuations, including background; and
- There would have been no exceedance or violation but for the event.

This report documents that the event meets the above criteria and provides analysis to demonstrate that:

- The wildfire and high wind events were not reasonably controllable or preventable;
- There is a clear-causal connection between the wildfires and the high winds and the exceedances at numerous monitoring sites;
- The measured concentrations were beyond normal historical levels; and
- The exceedances would not have occurred "but for" the wildfires and/or the strong winds.

Analysis Methods

The following document demonstrates that a clear causal relationship existed between the wildfires seen over Southern California in October of 2007, the high winds from the cold front passage and the extreme pressure gradients over the western continental United States, and the exceedances measured at the monitors. This analysis utilized monitoring and meteorological data, satellite images, smoke and fire detection analysis, parcel trajectories, emissions information, and historical data. ARB staff concludes that, but-for the wildfires and the high winds, the measured concentrations at the monitors would not have exceeded the NAAQS.

Monitoring Network and Air Quality Data. The State of California's particulate matter monitoring network consists of both PM_{10} and $PM_{2.5}$ FRM (filter-based) and PM_{10} FEM (Tapered-Element Oscillating Microbalance (TEOM) or Beta Attenuation Method (BAM)) monitors operating on continuous, daily, and schedules that include monitoring every third day (1-in-3 or 1/3 day), every sixth day (1-in-6 or 1/6 day), and every twelfth day (1-in-12 or 1/12 day). Additional PM monitors, not considered either FRM or FEM, were in operation in the affected areas. These monitors were heavily utilized for forecasting purposes. Smoke, dust, and ash were present throughout the last days of October and into November.

Meteorological Data. Meteorological data (Appendix C) was obtained from various sources, including the California Air Resources Board, the California Irrigation Management and Information System (CIMIS), the National Weather Service, and the Weather Underground. Data is used to determine basic meteorological conditions before, during, and after the exceptional event.

Satellite Data. Satellite data was utilized to aid in visual confirmation of smoke in the atmosphere. Direct images showing the layers of smoke over California (Appendix E), as well as those layers constructed from analyst observations (Appendix F), correlate well with $PM_{2.5}$ data obtained from monitoring sites throughout the region.

Day-by-day smoke analysis by National Oceanic and Atmospheric Administration (NOAA) Hazard Mapping System (HMS) Fire and Smoke Product during the fall of 2007, details the extreme combined smoke impacts of these fires (Appendix F). As noted by the NOAA Satellite and Information Service, the HMS is an interactive processing system. Trained satellite analysts in the Satellite Analysis Branch (SAB), within the Satellite Services Division (SSD), manually integrate data from various automated fire detection algorithms with GOES and polar satellite images (Advanced Very High Resolution Radiometer (AVHRR), Moderate Resolution Imaging Spectroradiometer Fire Algorithm (MODIS) and Defense Meteorological Satellite Program/Operational Linescan System (DMSP/OLS)). These products display both fire locations and significant smoke plumes. Smoke layers that can be used with geographic information system (GIS) programs are then generated. Layer construction is restricted to discrete time periods (passage of overhead satellites) and geometric areas and does not always reflect complete smoke plume boundaries or even all areas visible in satellite images[3]. Additionally, the presence of cloud cover can restrict the detection of fires and smoke plumes. Therefore, there are days that increased PM concentrations due to smoke are not reflected in the constructed smoke layers.

Air Parcel Trajectories. Air parcel trajectories, used to determine the source of impacts on a monitoring site, were modeled using the NOAA Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) Model. This model has been used by the U.S. EPA to help evaluate causal connections between suspected source regions (e.g., a wildfire's smoke plume) and event receptors (e.g., a monitoring site).

Emissions and Control Measures. Anthropogenic sources near the monitors played only a small role in the particulate matter levels seen at the sites where we are requesting an exceptional event determination. Reasonable and appropriate controls were in place in all affected Districts to reduce PM from anthropogenic sources, but conditions were such to overwhelm any control measures. Therefore, this natural event and the associated exceedances were not reasonably controllable or preventable.

Overview of Event

This was a widely documented event that began with the ignition of the Ranch Fire in Los Angeles County on Saturday, October 20, 2007. Numerous additional fires were fueled by strong Santa Ana winds, which helped spread smoke, dust, and ash throughout Southern California. On October 21, the Governor of California declared a State of Emergency for Los Angeles, Orange, Santa Barbara, Ventura, Riverside, San Bernardino, and San Diego Counties.

The Federal Emergency Management Agency (FEMA) followed suit on October 24, declaring all seven counties disaster areas. At its peak, the deadly Southern California Fire Siege[4,5] comprised almost 20 major wildfires, with several smaller fires contributing to the pall of smoke over the region. By the time the last fire had been declared contained on November 13, over a half-million acres had burned, thousands of buildings had been destroyed, and almost a million residents had been displaced.

The PM monitoring sites requested for exclusion in this document were in close proximity to the wildfires (Figure 1) and many were not only severely impacted by smoke but by dust and ash entrained and transported by the strong winds. The satellite image in Figure 2 illustrates the extent of the wildfire and high wind events on the western portion of Southern California. The NOAA smoke analysis product from October 22, shows smoke covering the region (Figure 3).

Figure 2. MODIS Satellite Image – October 22, 2007
Smoke across Southern California
[http://www.osei.noaa.gov/Events/Fires/US_California]

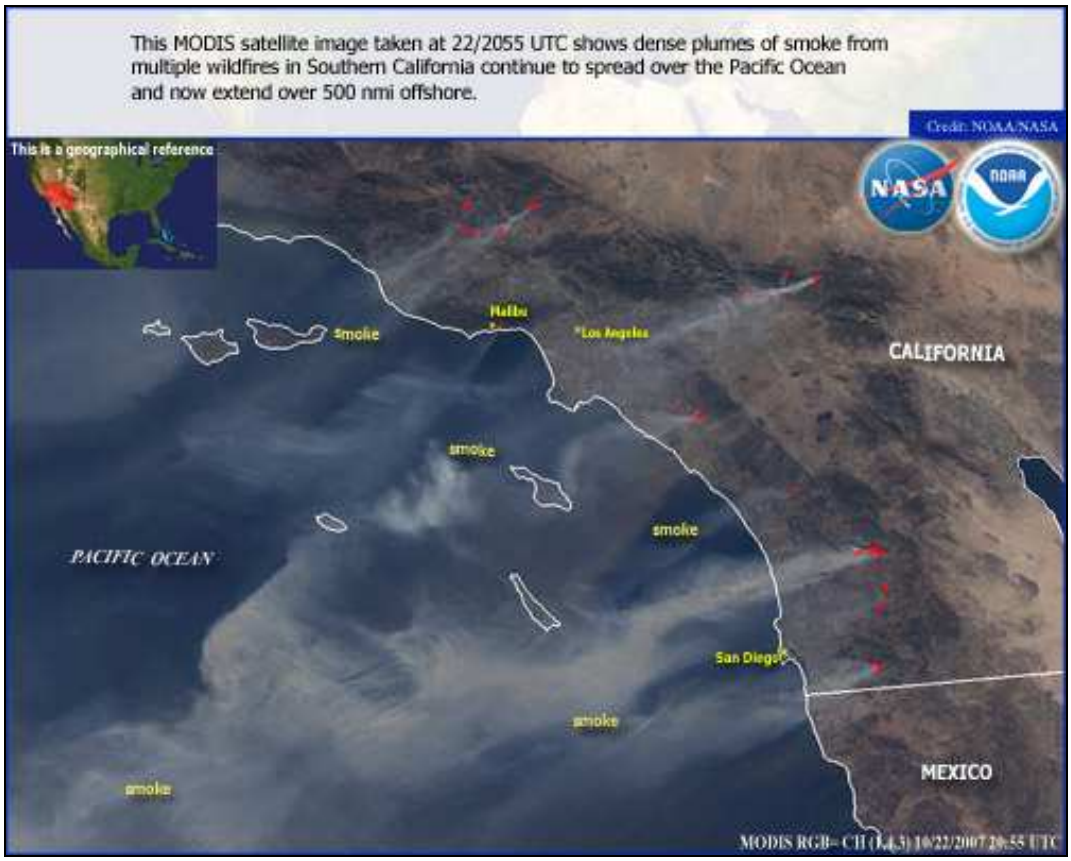
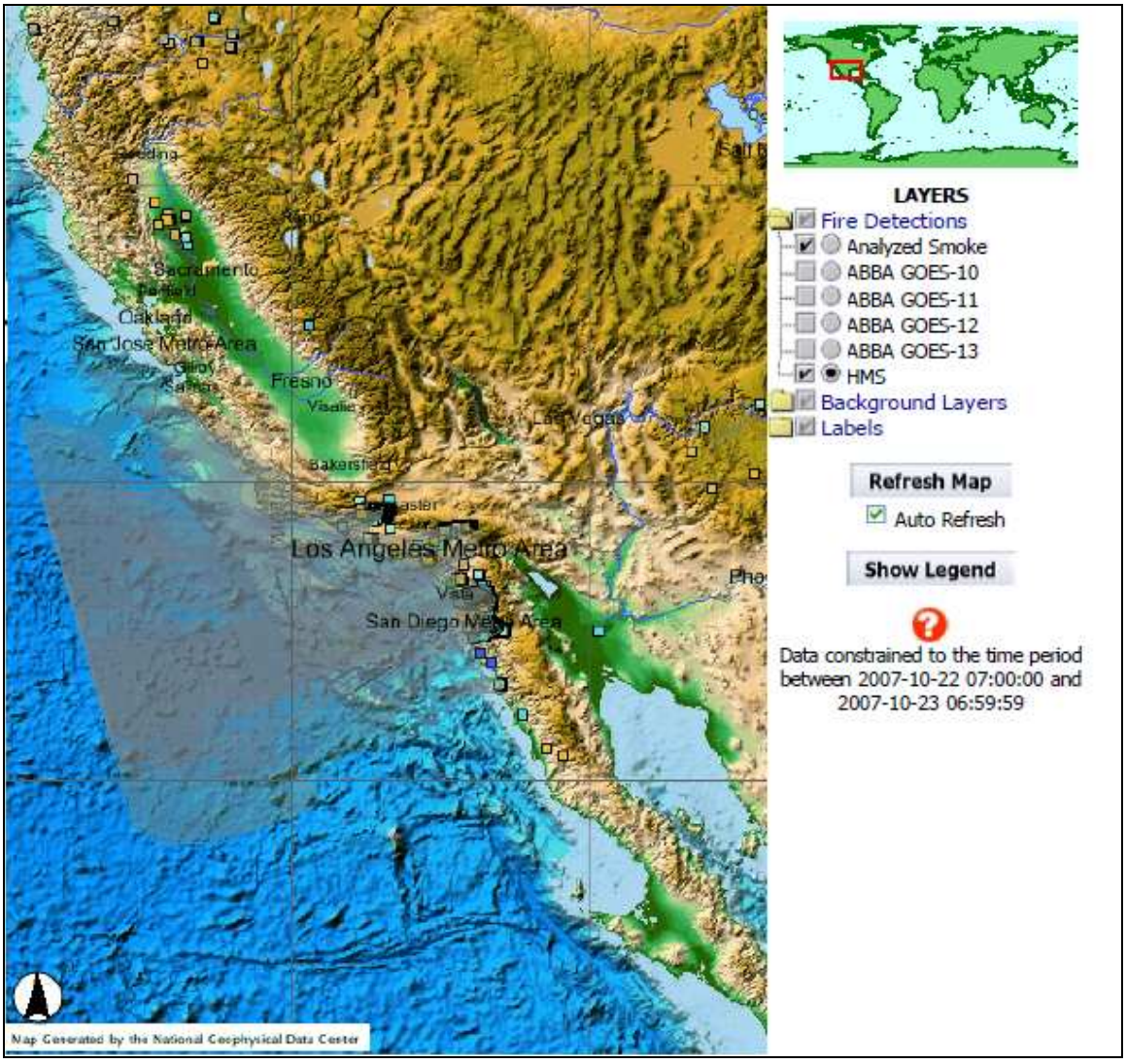


Figure 3. NOAA Satellite Fire Detection Smoke Analysis Product
October 22, 2007



PM mass concentration data from monitoring sites throughout Southern California show the direct impact of these events on ambient air quality (Figures 4 and 5). The figure columns include data from all monitoring sites (represented by a horizontal line), effectively showing all concentrations in one column for each day. Both $PM_{2.5}$ and PM_{10} concentrations rose to levels that exceeded the 24-hour NAAQS at many sites. The $PM_{2.5}$ exceedances shown prior to the October 2007 wildfires occurred in the South Coast Air Basin, are not typical for this time of year, and are currently being investigated. The concentrations after November 5, the last day requested in this document, were also impacted by the wildfires, but did not meet the basic criteria to be included in this request.

Figure 4. Regional Maximum $PM_{2.5}$ FRM Concentrations at Southern California Monitoring Sites - September 1 to November 30, 2007.

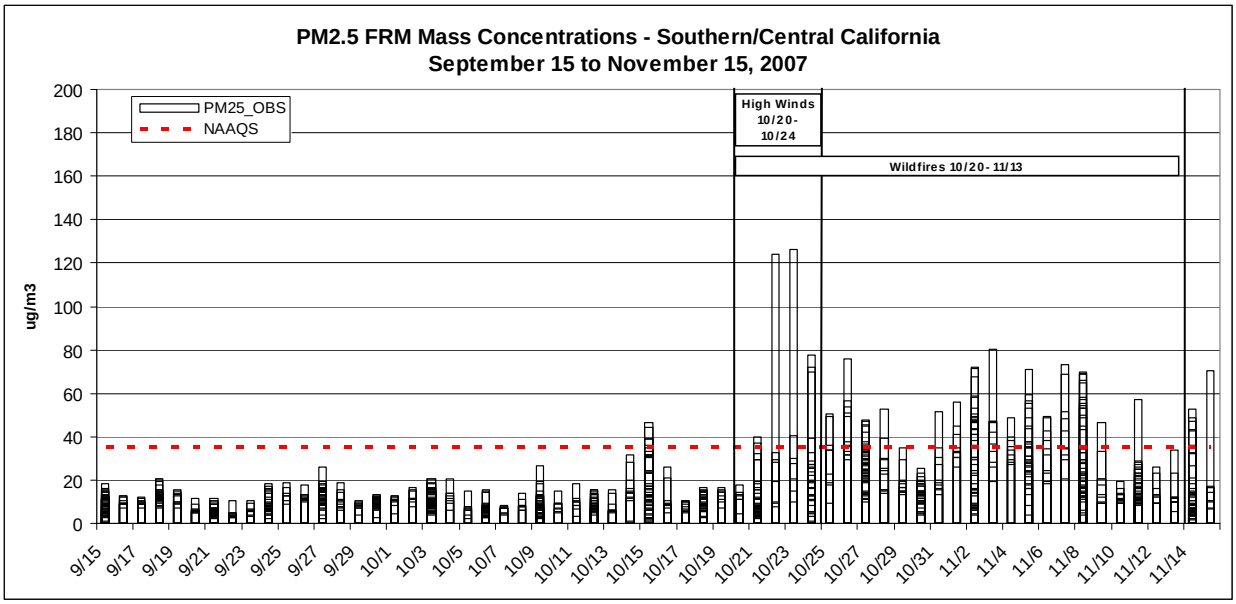
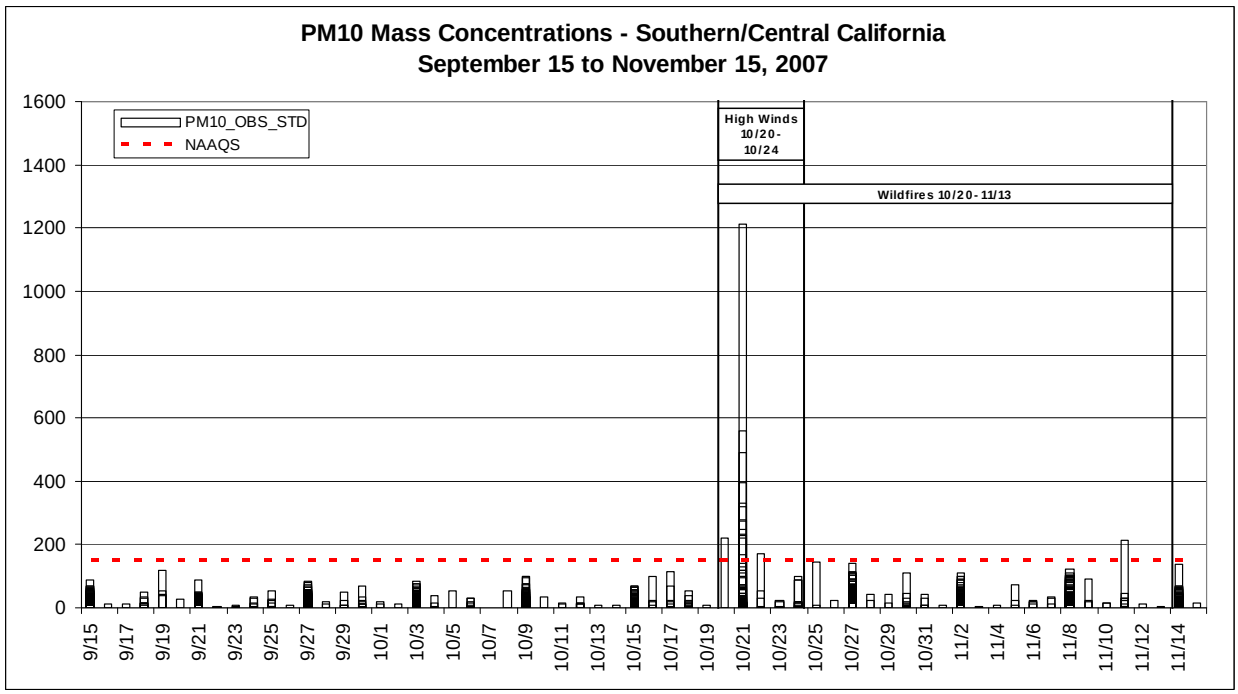


Figure 5. Regional Maximum PM_{10} FRM Concentrations at Southern California Monitoring Sites - September 1 to November 30, 2007.



Clear Causal Connection

In the afternoon of October 20, 2007, a strong cold front brought high winds to the region, impacting several sites. That evening, the first of numerous wildfires, the Ranch Fire, was reported in Los Angeles County. Over the next few days, additional wildfires were reported from Santa Barbara County to the San Diego County border with Mexico (Table 2 and Figure 6). The smoke and ash impact of these fires was exacerbated by strong Santa Ana winds which officially began on October 21 with peak wind gusts in some areas over 100 mph. These record-breaking winds entrained and transported dust and ash as well as smoke from the wildfires to numerous monitoring sites in the region. Many of these sites, comprising both Federal Reference Method (FRM) and Federal Equivalent Method (FEM) monitors, exceeded the National Ambient Air Quality Standards (NAAQS) for both $PM_{2.5}$ and PM_{10}. The figures on the next pages (Figures 6, 7, and 8) show the locations of the primary individual and complex fires; not all contributing fires are listed or shown on these maps.

Table 2. Major Federal Wildland Fire Incidents in Southern/Central California October 20 -November 13, 2007[4,5,6]

Map Number	Incident Number	Incident Name	Latitude	Longitude	Size (acres)	Start Date	Containment Date
1	CA-MCP-001111	Ammo	33.380278	117.508611	21,004	10/23	10/28
2	CA-LAC-07232185	Buckweed	34.528333	118.343889	38,356	10/21	10/24
3	CA-BDU-11627	Cajon	34.236389	117.425	250	10/22	10/23
4	CA-LAC-07231849	Canyon	34.056667	118.694167	4,521	10/21	10/25
5	CA-SMC-20070005592	Coronado Hills	33.112222	117.154722	250	10/22	10/22
6	CA-BDF-10566	Grass Valley	34.273333	117.215278	1,247	10/23	10/30
7	CA-MVU-010427	Harris	32.591111	116.584722	90,440	10/21	10/31
8	CA-LAC-07233077	Magic	34.422222	118.583333	2,824	10/22	10/24
9	CA-BDU-011653	Martin	34.216389	117.377222	123	10/23	10/25
10	CA-CNF-2786	McCoy	33.042222	116.6425	unk	10/21	10/26
11	CA-MVU-10643	Poomacha	33.2775	116.868056	49,410	10/23	11/13
12	CA-ANF-4306	Ranch	34.573056	118.695278	58,401	10/20	10/30
13	CA-MVU-01052	Rice	33.396944	117.148056	9,472	10/22	10/28
14	CA-RRU-91948	Roca	33.455833	116.859444	270	10/21	10/22
15	CA-RRU-92560	Rosa	33.494444	117.178333	411	10/22	10/24
16	CA-ORC-68555	Santiago	33.745833	117.666667	28,400	10/21	11/8
17	CA-LPF-1783	Sedgewick	34.734167	120.005	710	10/21	10/23
18	CA-BDF-10570	Slide	34.2825	117.216111	12,759	10/23	10/31
19	CA-MVU-010432	Witch	33.118056	117.216389	197,990	10/21	10/31

Figure 6. PM Monitoring Sites and Wildfires Locations.
[Wildfire numbers correspond to locations listed in Table 2]

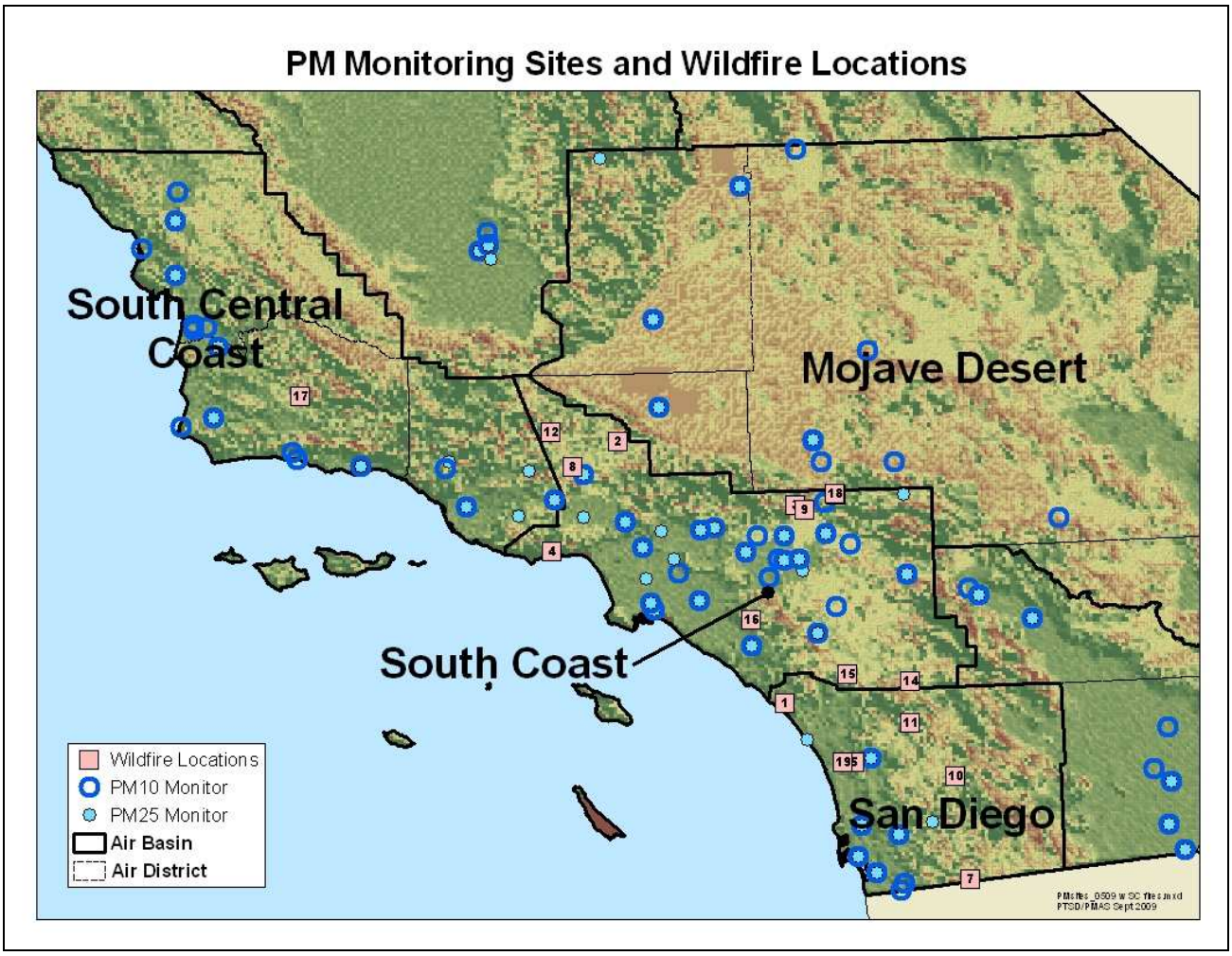


Figure 7. California Wildfires as of October 23, 2007.
[California Department of Forestry and Fire Protection: http://www.fire.ca.gov;
California Office of Emergency Services: http://www.oes.ca.gov]

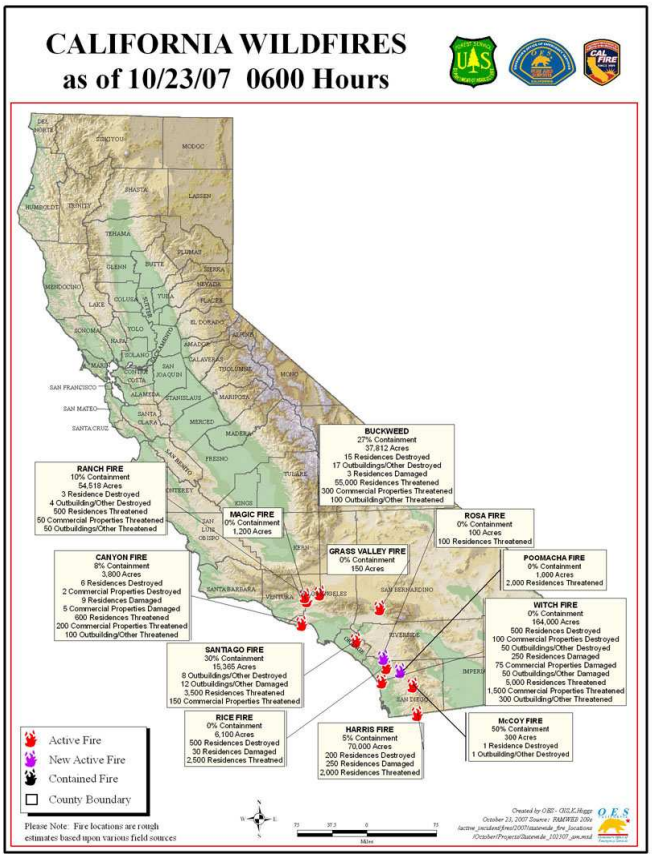


Figure 8. U.S. Large-Scale Wildfires - October 23, 2007.
[National Interagency Fire Center (NIFC)]

As predicted by the National Weather Service, which began to issue high wind warnings on October 20[1], strong pressure gradients developed at both the surface and the upper atmosphere (Figures 9 and 10). These strong gradients brought strong winds to the region and the further development of a high pressure area over the Great Basin area resulted in the strong Santa Ana winds seen throughout southern California. Backward parcel trajectories of representative sites (trajectories for individual sites are included in Appendix C.3) for the afternoon of October 21 show the strong consistent flow across the Mojave Desert to the California coast (Figure 11).

Figure 9. Mean Sea Level Pressure Contour Analyses – October 20 and 21, 2007.

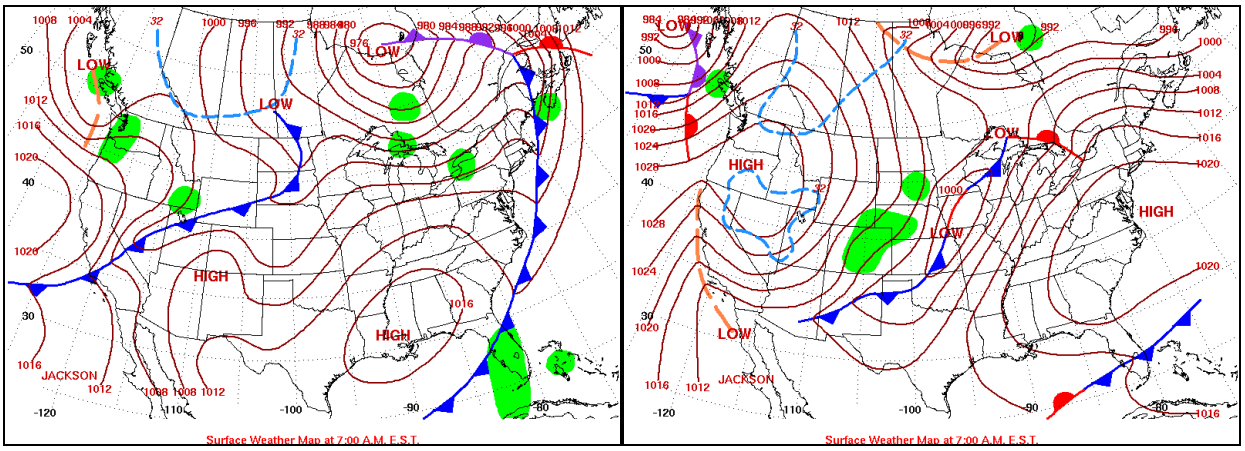


Figure 10. Upper Atmosphere (500 millibar level) Constant Height Contour Analyses – October 20 and 21, 2007.

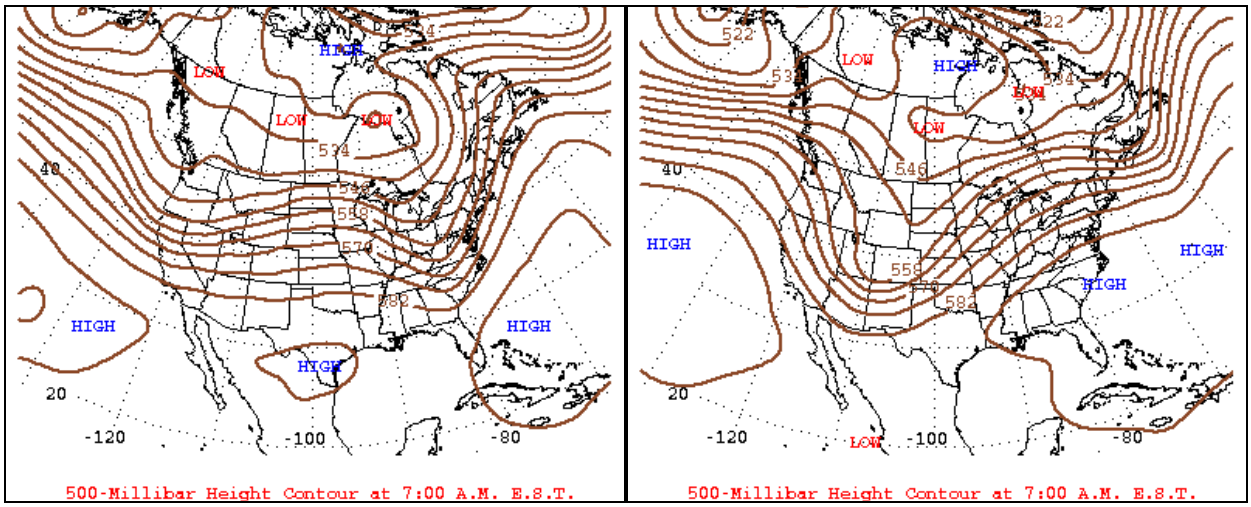
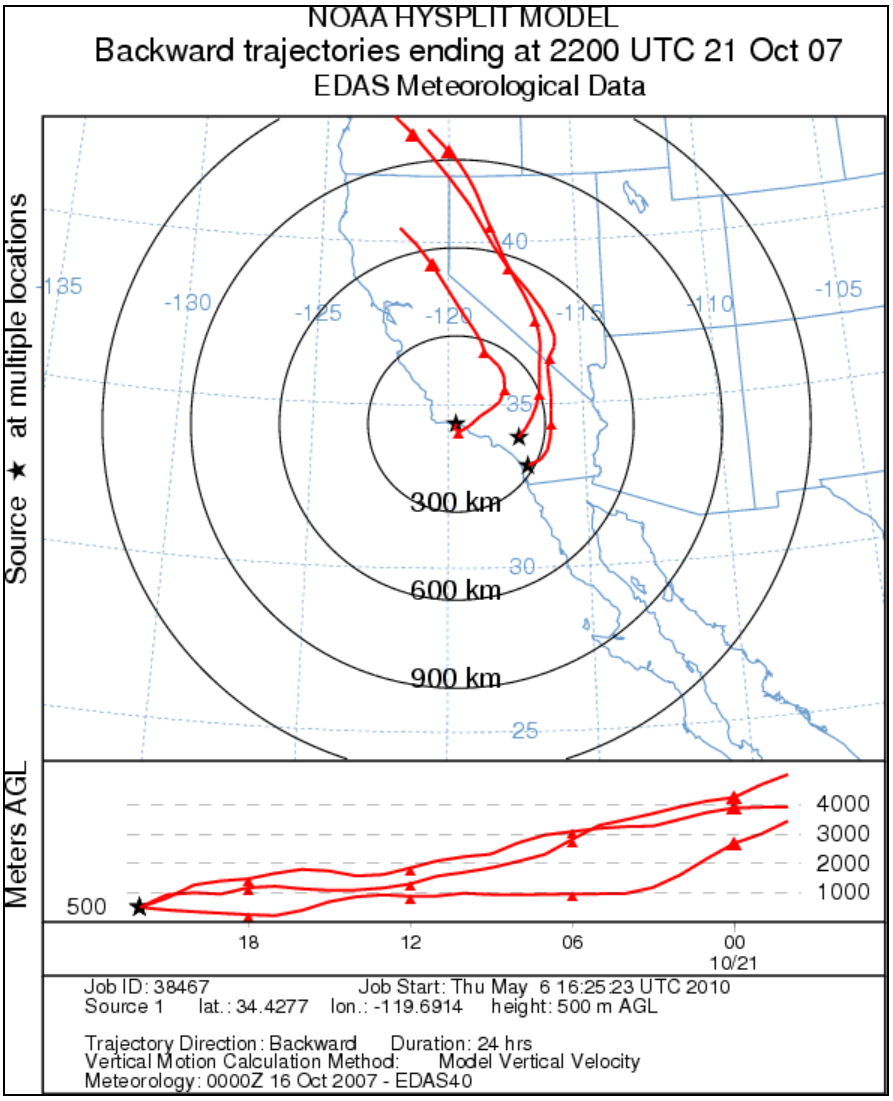


Figure 11. NOAA HYSPLIT Model 24-Hour Back Trajectories Reaching Santa Barbara, Perris, and Escondido Monitoring Sites at 1500 PST (2200 UTC) on October 21, 2007.
(HYSPLIT Use Agreement: http://www.ready.noaa.gov/ready/hysplit_agreement.html)



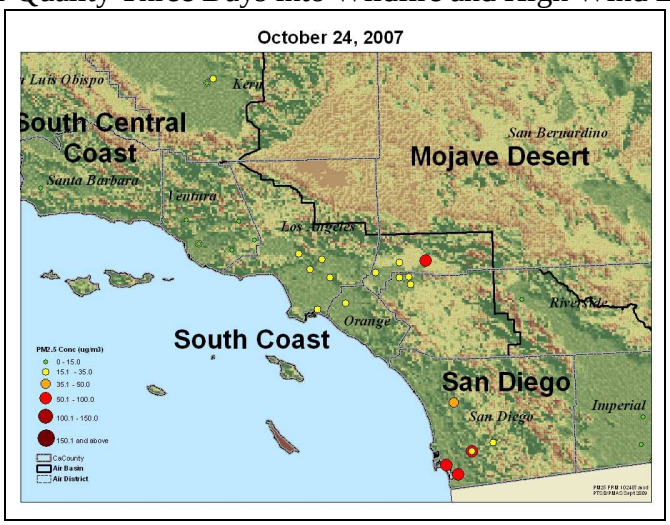
The effect of both the high winds and wildfires on regional air quality was notable. The following maps show data from all $PM_{2.5}$ monitors, including non-FRM/FEM monitors, in the Southern California region. On October 18, a 1/3-day sampling day two days before the first fire and the beginning of the Santa Ana wind event, most sites in Southern and Central California had $PM_{2.5}$ concentrations below the 24-hour NAAQS of 35 $\mu g/m^3$ and many were below the Annual Average NAAQS of 15 $\mu g/m^3$ (Figure 12a). This changed after October 20, with air quality deteriorating across the region. $PM_{2.5}$ and PM_{10} concentrations increased, as depicted in the maps for October 21 (a 1/6-day sampling day) and October 24 (a 1/3-day sampling day) (Figures 12b and 12c).

Figure 12. $PM_{2.5}$ FRM Mass Concentrations in Southern California.

a. Air Quality Prior to Wildfire and High Wind Events

b. Air Quality at Beginning of Wildfire and High Wind Events

c. Air Quality Three Days into Wildfire and High Wind Events



Total carbon concentrations, a good marker for smoke, correlate well with the increase in $PM_{2.5}$ seen at several area monitoring sites in October (Figure 13). Other wood burning markers (levoglucosan, mannosan, and galactosan) were measured at only one site – Escondido in the San Diego Air Basin (Figure 14). October 27, the only affected day that was also a monitoring day, had levels of all three wood burning markers well above the October monthly average of the previous three years.

Figure 13. Multi-Site $PM_{2.5}$ Mass and Total Carbon Concentrations, October 2007.

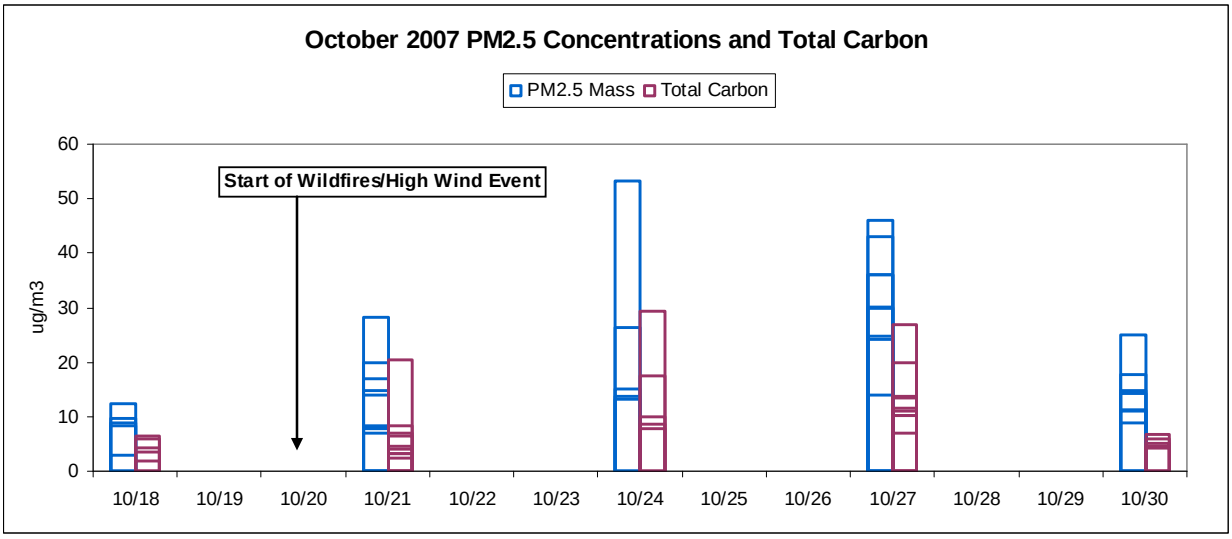
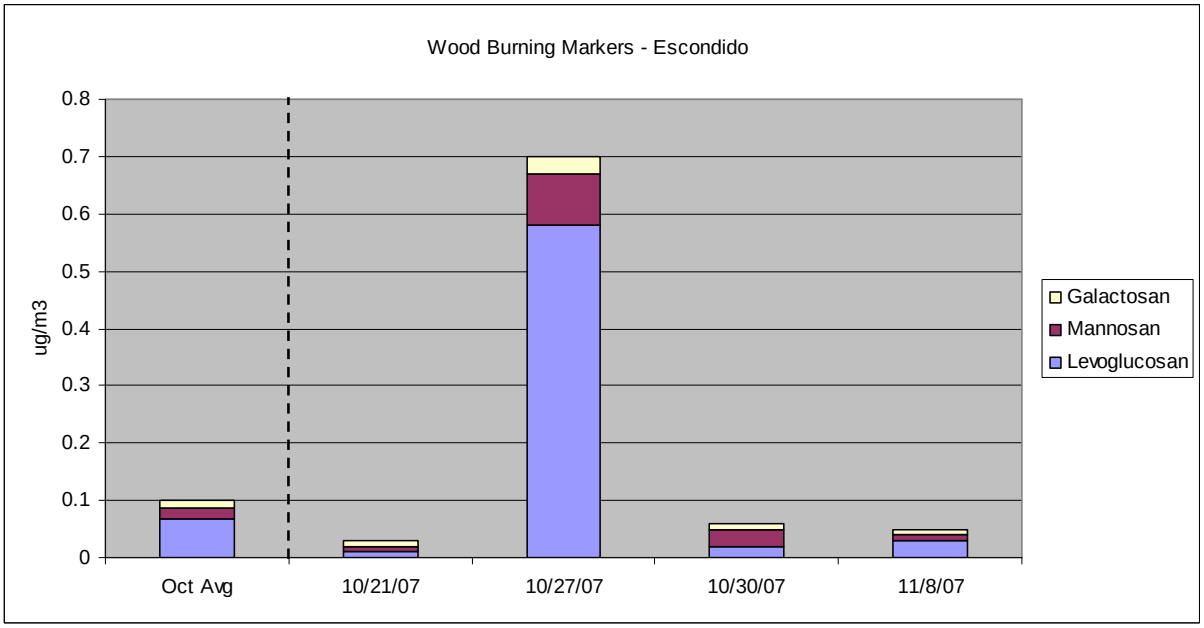


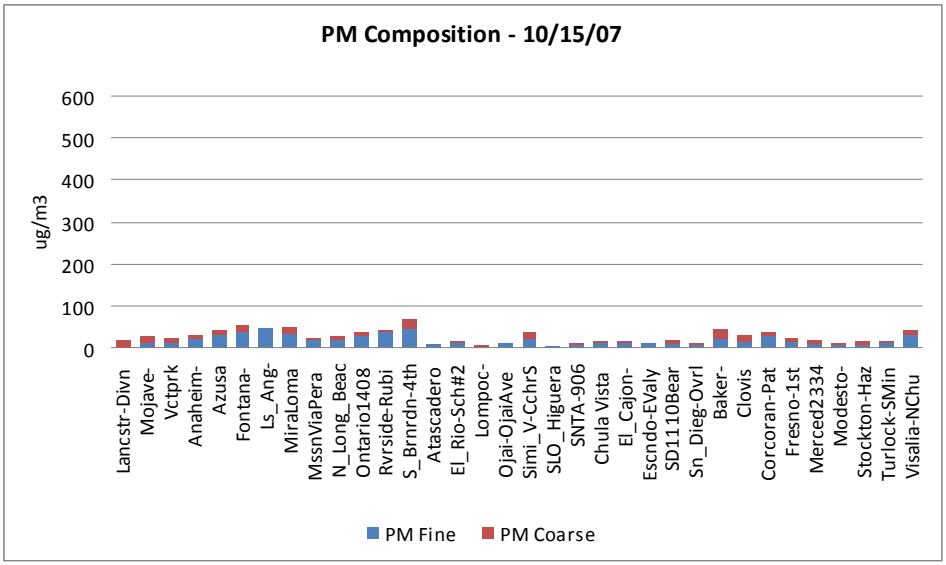
Figure 14. October 2007 Wood Burning Marker Levels at Escondido Comparison to October Average Levels.



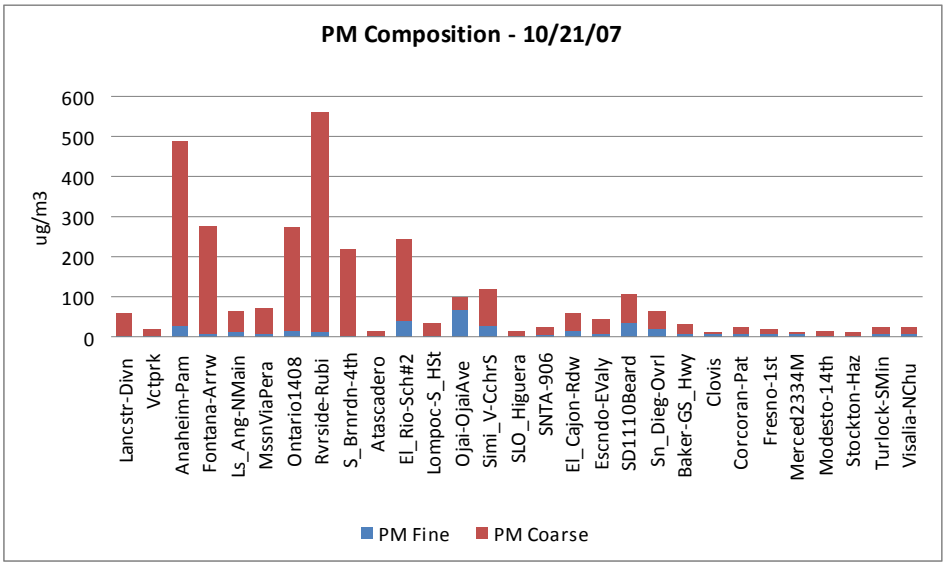
The impact of coarse particulate matter, comprised primarily of dust and ash entrained and transported by the high winds at the start of the event, can be seen clearly in both the increased levels of PM_{10} and the relationship between $PM_{2.5}$ and PM_{10} in the region (Figure 15). The high ratio of fine PM ($PM_{2.5}$ and smaller) to coarse PM (between $PM_{2.5}$ and PM_{10}) for October 15 indicated that, prior to the start of the event, the majority of PM was in the fine range. The dramatic switch to a higher coarse component seen on October 21, as well as the drastic increase in PM concentrations, illustrates the impact of the wind-entrained dust and ash on the region. By October 27, the high wind event had lessened and $PM_{2.5}$ had again become a larger percentage of the PM mass concentrations, although not yet as high as seen before the start of the event.

Figure 15. $PM_{2.5}/PM_{10}$ Ratios

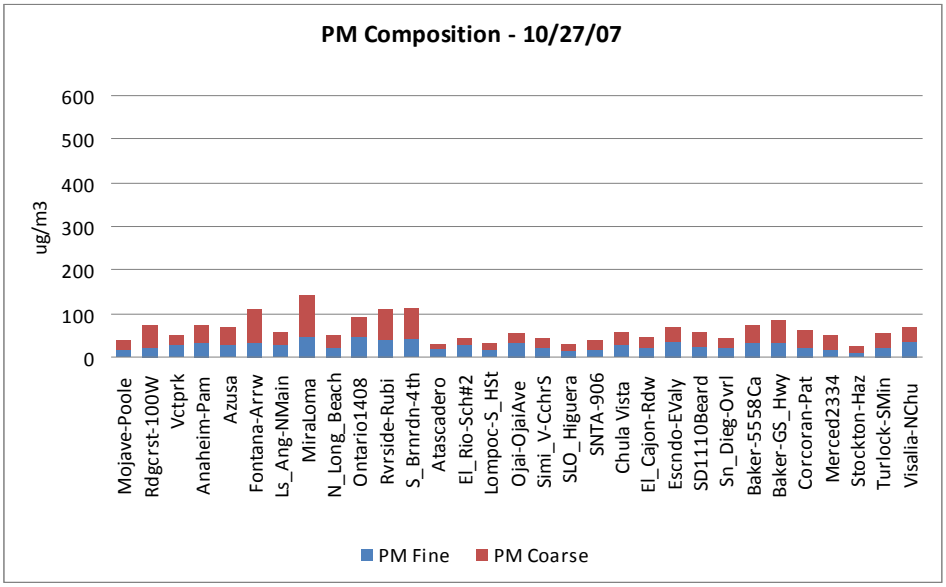
a. October 15, 2007



b. October 21, 2007



c. October 27, 2007



Event Analysis

The major influences on smoke and dust transport over Southern and Central California are described in this section. Detailed meteorological data, including airport wind reports and surface and upper-air meteorological charts, are included in Appendix C.1. Additional separate analyses of these high wind and wildfire events can be found in supporting documents in Appendix I.

Basic Chronology

October 20. A strong cold front, bringing with it tight pressure gradients and high winds, moved across California on October 20. These strong pressure gradients, both at the surface and in the upper atmosphere, prompted the National Weather Service to issue high wind warnings for Southern California. Vandenberg Air Force Base reported winds up to 36 mph with gusts up to 47 mph. Blowing dust was reported in several areas and NOAA's Smoke Text Product noted visible dust moving across both Santa Barbara and Ventura Counties in the South Central Coast Air Basin as well as the southern portion of the San Joaquin Valley. PM_{10} concentrations at hourly monitors began to rise along with the wind in the early afternoon[1], with hourly concentrations at Santa Barbara reaching over 900 $\mu g/m^3$ (Figure 16). The daily average PM_{10} concentration at Santa Barbara (a non-FRM monitoring site) reached a record 400 $\mu g/m^3$. The FEM monitor at Victorville in the Mojave Desert recorded an average PM_{10} concentration of 180 $\mu g/m^3$, with hourly concentrations reaching as high as 600 $\mu g/m^3$ (Figure 17).

Figure 16. Rising Wind and PM_{10} TEOM Concentrations at Santa Barbara
October 19-20, 2007

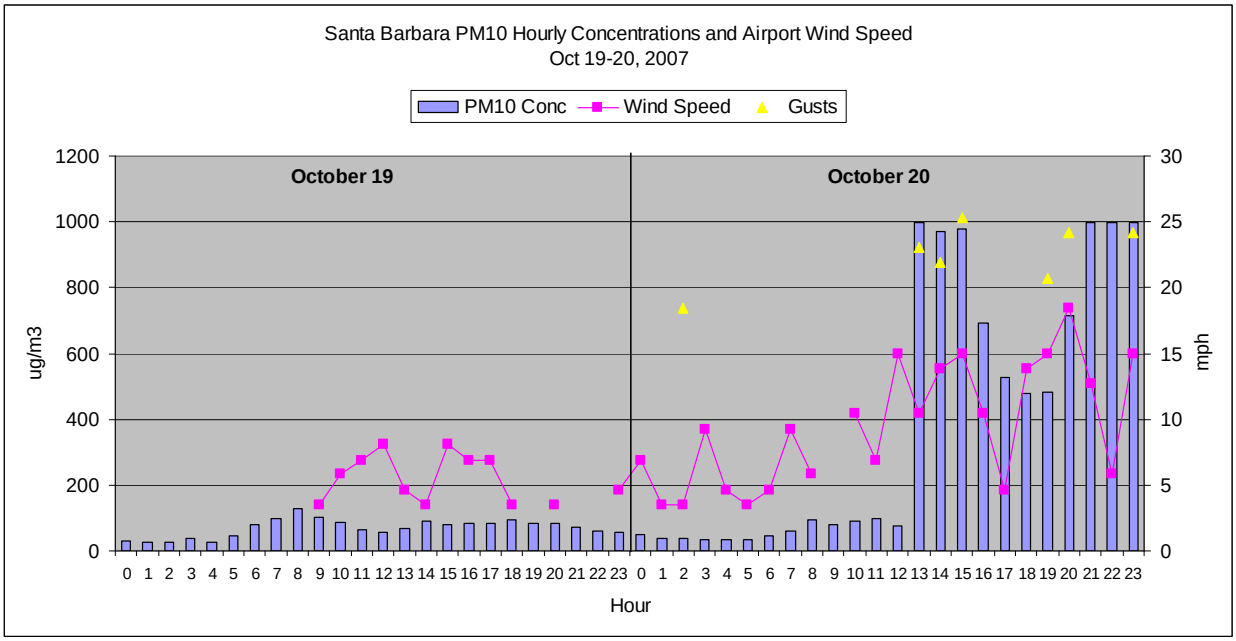
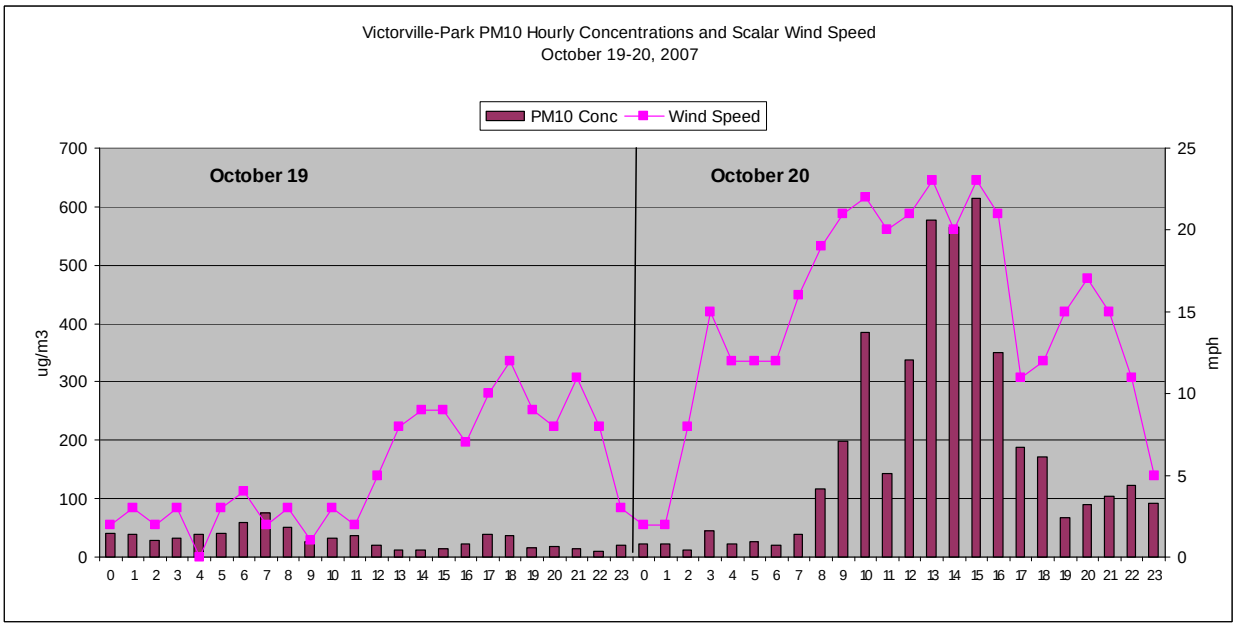


Figure 17. Rising Wind and PM_{10} TEOM Concentrations at Victorville
October 19-20, 2007



The Ranch Fire was reported in Los Angeles County in the evening of Saturday, October 20. This fire was the first of many that, combined, came to be known as the San Diego Firestorm 2007 and the California Fire Siege 2007[4,5].

October 21. The next day, Sunday, October 21, saw tremendous growth in both the number of wildfires and their cumulative impact. Smoke can be seen throughout the southwest coastal portion of the State and extending well offshore (Figure 18), pushed by the increasing offshore winds. The Governor of California declared a State of Emergency for seven Southern California counties; Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura.

Figure 18. Satellite Image of California Wildfires – October 21, 2007

USA5.2007294.aqua.2km.jpg [1835-1840 UTC]

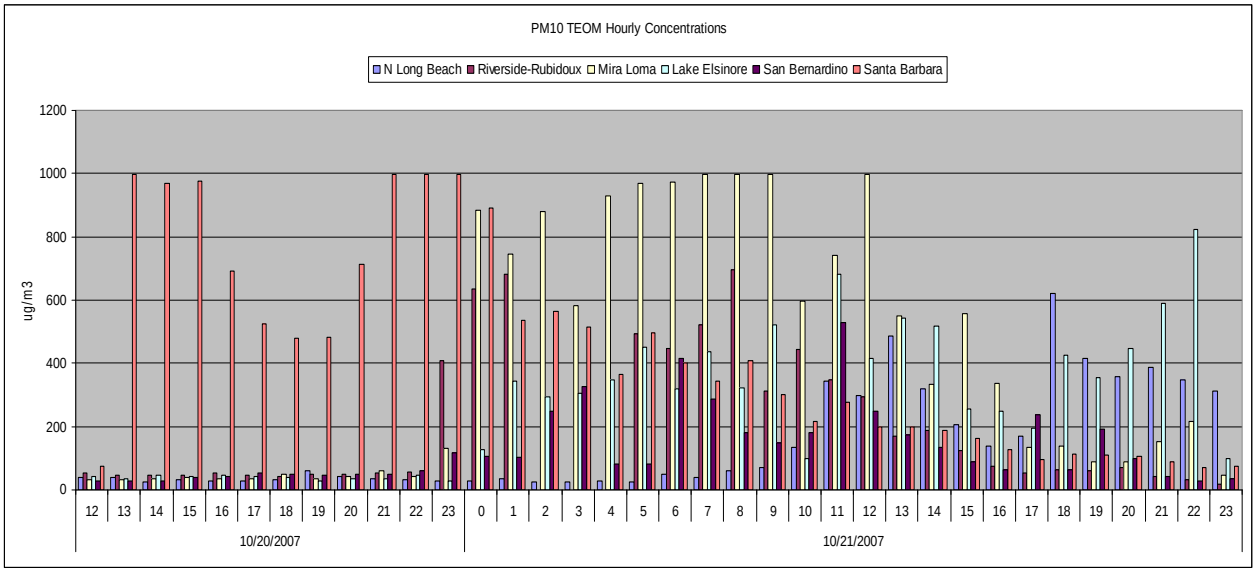
Following the passage of the cold front, a low pressure system developed off the coast of southern California, while a large surface high pressure system developed in the Great Basin Region of the western continental United States. Coupled with strong upper air support, these conditions generated the strong offshore winds known as Santa Ana winds, which brought extreme wind gusts, higher temperatures and drier conditions to the Southern California region. High winds were documented throughout the area, with the National Weather Service reporting winds of 111 mph north of Point Mugu in Ventura County[7]. These hurricane-level winds, and the resulting entrained dust and ash, contributed to exceedances at several PM_{10} monitoring sites (Table 3 and Figure 19).

The daily average PM_{10} concentration at the Santa Barbara monitoring site on October 21 was 286 μg/m^3, with hourly PM_{10} concentrations again reaching as high as 900 μg/m^3. These elevated concentrations, although impacted by the fires in the area, were primarily in the coarse range ($PM_{2.5}$-PM_{10}) and the result of dust entrained by the high Santa Ana winds and transported to the monitoring sites. This high wind event is also documented in a comprehensive analysis by the South Coast Air Quality Management District[1], confirmed by the Air Resources Board, and submitted for final determination to the U.S. EPA on December 12, 2009 (included in Appendix I.4).

Table 3. PM_{10} TEOM Concentrations in South Coast[1] and South Central Coast Air Basins – October 20-21, 2007 (concentrations exceeding 150 μg/m^3 are highlighted in **bold** type)

		PM_{10} Hourly Concentrations (μg/m^3)					
		South Coast					**South Central Coast**
Date	**Hour (PST)**	**N Long Beach**	**Riverside-Rubidoux**	**Mira Loma**	**Lake Elsinore**	**San Bernardino**	**Santa Barbara**
10/20/2007	12	38	53	33	41	28	74
	13	38	45	31	36	27	**997**
	14	24	45	37	45	30	**969**
	15	31	47	38	41	40	**978**
	16	27	53	34	46	44	**694**
	17	30	46	37	43	54	**526**
	18	33	41	51	38	49	**479**
	19	59	49	37	30	47	**483**
	20	41	50	41	37	51	**713**
	21	34	53	60	36	50	**997**
	22	31	57	42	45	62	**997**
	23	29	**408**	133	28	117	**997**
10/21/2007	0	27	**637**	**883**	128	107	**890**
	1	34	**680**	**744**	**345**	104	**536**
	2	24		**879**	**296**	**247**	**566**
	3	25		**581**	**306**	**328**	**515**
	4	27		**929**	**349**	81	**367**
	5	26	**493**	**970**	**450**	82	**497**
	6	51	**447**	**974**	**321**	**414**	**400**
	7	39	**522**	**999**	**435**	**288**	**343**
	8	60	**695**	**999**	**324**	**180**	**407**
	9	72	**312**	**999**	**522**	150	**303**
	10	135	**444**	**596**	99	**181**	**216**
	11	**343**	**349**	**741**	**682**	**529**	**276**
	12	**297**	**293**	**997**	**417**	**247**	**198**
	13	**486**	**170**	**552**	**544**	**175**	**199**
	14	**319**	**187**	**333**	**517**	134	**187**
	15	**205**	124	**556**	**257**	88	**162**
	16	139	75	**338**	**249**	65	129
	17	**170**	53	134	**194**	**237**	97
	18	**622**	65	137	**425**	65	115
	19	**415**	59	90	**355**	**193**	109
	20	**358**	70	90	**447**	98	107
	21	**388**	44	**154**	**590**	42	90
	22	**348**	33	**216**	**824**	29	71
	23	**313**	19	46	99	37	76

Figure 19. PM_{10} TEOM Concentrations in South Coast and South Central Coast Air Basins – October 20-21, 2007

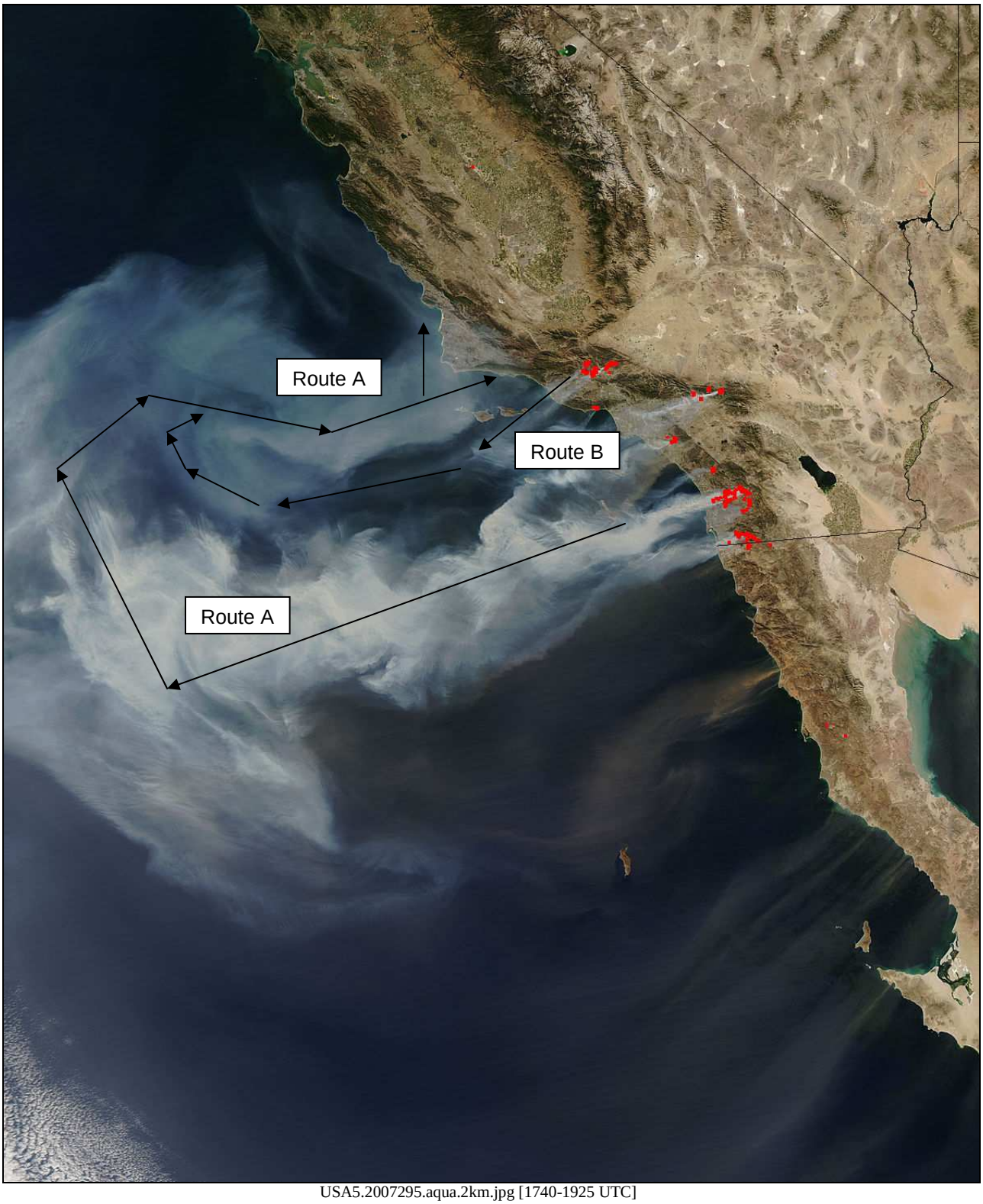


October 22. Strong Santa Ana winds continued to plague the region and several more fires joined those already burning. Satellite images (Figures 20 and 21) show the continuing westward trail of the wildfire smoke plumes. These plumes extended over the South Coast and San Diego Air Basins, flowing outward over the ocean for several hundred miles.

Afternoon satellite images (Figure 20) depict dense smoke plumes turning northward and circulating back to the coast over Santa Barbara and western Ventura Counties, further impacting the monitoring sites in these regions (see estimated Routes A and B on Figure 20). Surface weather observations at Vandenberg Air Force Base (Appendix C.4) strengthen the probability of recirculated emissions with reports of onshore winds and smoke in the afternoon and extending late into the evening.

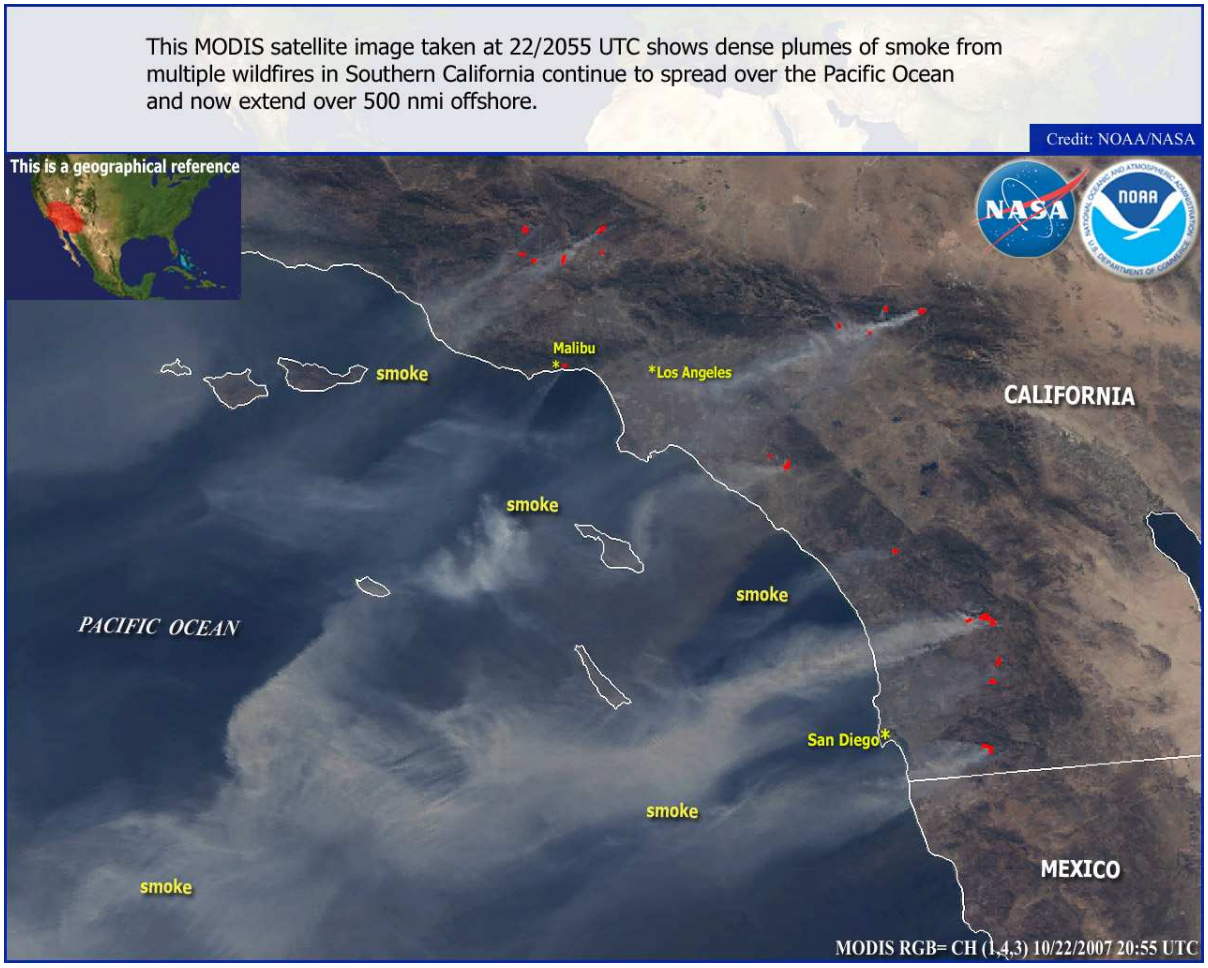
In addition to the presence of recirculated smoke, smoke from wildfires in northern Los Angeles County spread to the southwest over Ventura County and, from there, offshore over the Channel Islands. These plumes eventually met with the smoke recirculating in the Santa Barbara Channel region. The Santa Barbara Airport reported smoke and haze, along with lowering visibilities in the afternoon. The wind profiler located at Goleta near the Santa Barbara Airport, measured primarily westerly winds at 1000 feet, indicating that the recirculated air had reached the shoreline of Santa Barbara County (Appendices C.4 and I.3).

Figure 20. NOAA Satellite Image of California Wildfires – October 22, 2007



USA5.2007295.aqua.2km.jpg [1740-1925 UTC]

Figure 21. NOAA MODIS Satellite Image – October 22, 2007

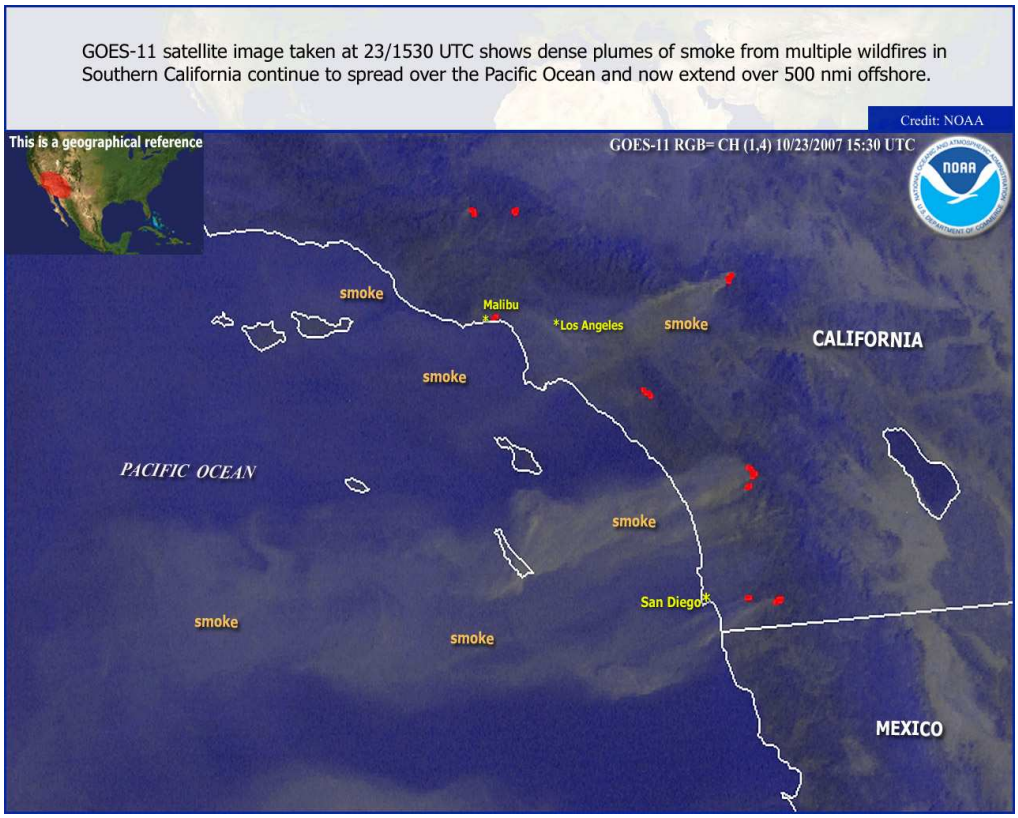


October 23. Santa Ana conditions continued throughout the next day, although to a lesser degree than previously experienced. Sustained winds up to 25 mph and some wind gusts of up to 40 mph were still in evidence, but many areas began reporting both lower sustained wind speeds and fewer wind gusts. These calmer conditions allowed smoke and haze to settle in the region, although satellite images still showed smoke extending hundreds of miles over the ocean, indicative of the continuing Santa Ana influence. Visible smoke was beginning to dissipate as some fires were brought under control, but smoke from others remained strong (Figures 22 and 23).

Figure 22. NOAA Satellite Image of California Wildfires – October 23, 2007

USA5.2007296.aqua.2km.jpg [1825-2005 UTC]

Figure 23. NOAA GOES-11 Satellite Image of Southern California – October 23, 2007.



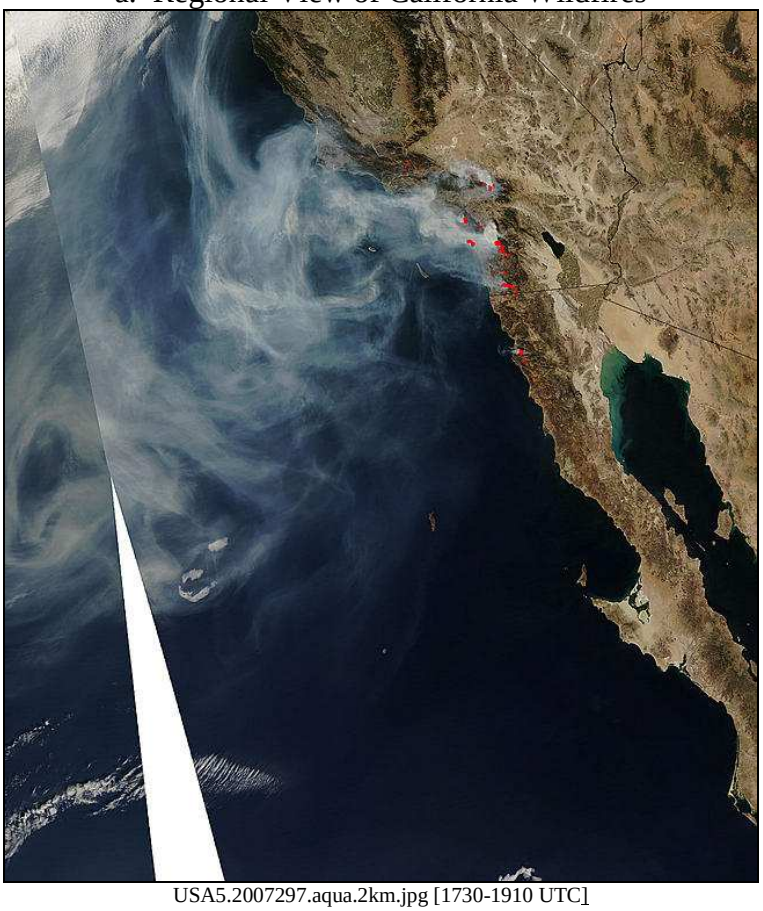
Surface wind observations in Santa Barbara County indicated weak offshore flow throughout the morning hours. The Santa Barbara Airport reported calm to light winds, along with hazy conditions and lower visibilities from early morning through the afternoon hours. Vandenberg Air Force Base also reported light onshore winds in the morning and smoke throughout the day. Later morning and early afternoon saw strong offshore winds, particularly over eastern Ventura County.

Conditions at the San Diego Airport in the morning were similar to those seen further north, fairly calm with light winds and smoky conditions. Wind speeds increased in the afternoon, but the presence of smoke remained a constant.

October 24. On Wednesday, October 24, the Federal Emergency Management Agency (FEMA) declared a State of Emergency for the counties of Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura. By this time, the Santa Ana episode had continued to lessen with the weakening of the high pressure system over the western portion of the U.S. This created a more consistent pattern of lighter winds across the region, allowing for a resurgence of the afternoon onshore flow. Satellite images continued to show wildfire smoke trailing across southern California into the Pacific (Figure 24), but without the strong westward streaming evident earlier. Smoke impacts continued to be reported at Vandenberg Air Force Base and San Diego Airport.

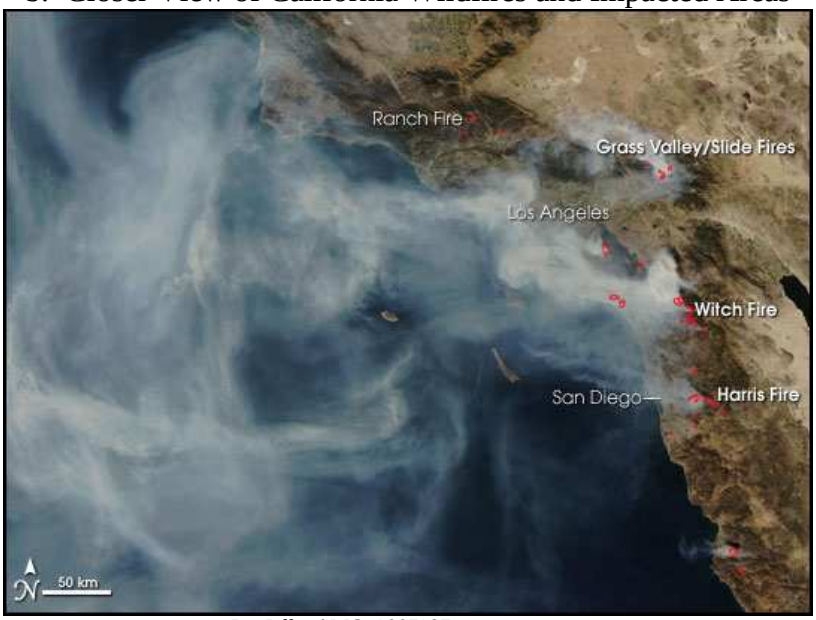
Figure 24. NOAA Satellite Image of California Wildfires – October 24, 2007

a. Regional View of California Wildfires



USA5.2007297.aqua.2km.jpg [1730-1910 UTC]

b. Closer View of California Wildfires and Impacted Areas



La_Jolla_AMO_2007297_eonasagov.jpg

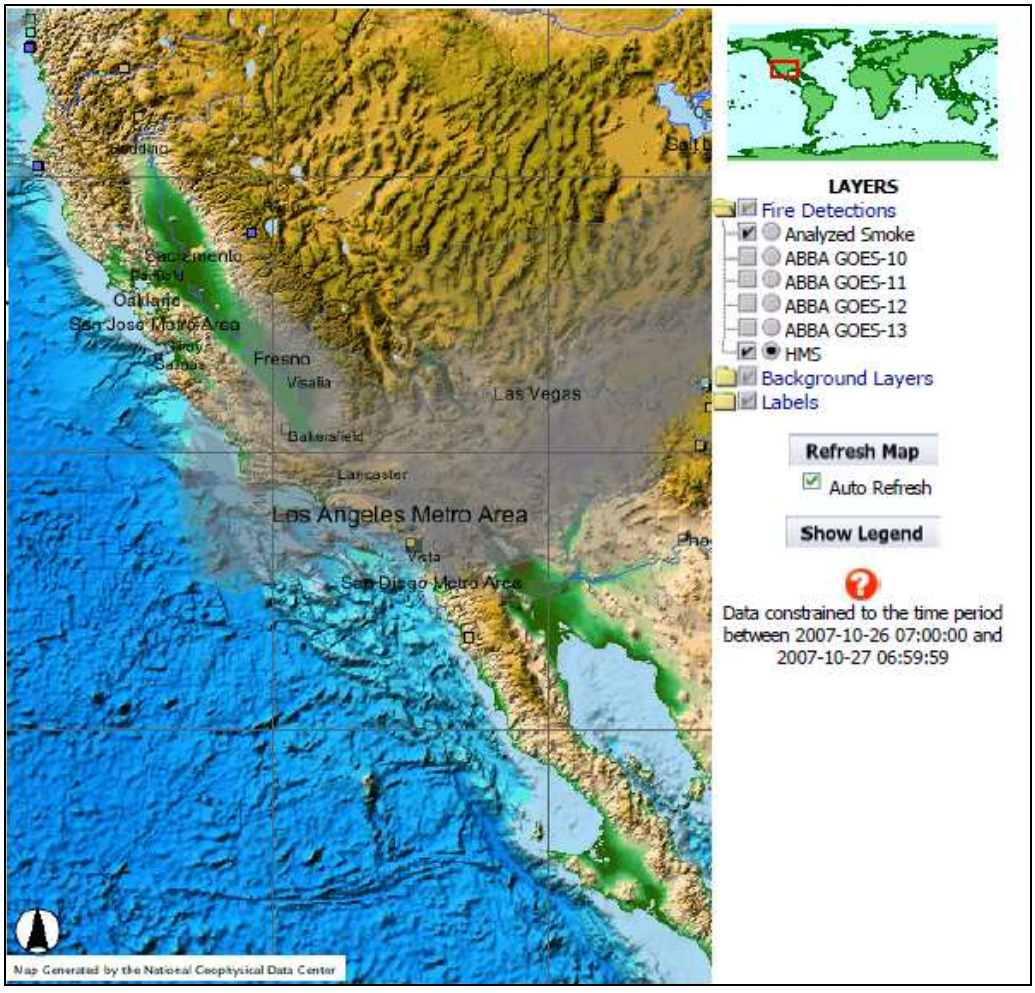
October 25. The high pressure system over the Great Basin area that was fueling the Santa Ana winds continued to weaken and winds began to return to more typical patterns for the region, light offshore/downslope flow at night and in the mornings with onshore/upslope flow in the afternoons. Although still very much present, the massive amounts of smoke from the fires had begun to lessen as well as more and more of the fires were brought under containment. But, as shown in the satellite image below (Figure 25), the smoke, unrestrained by offshore winds, began to move inland.

Figure 25. NOAA Satellite Image of California Wildfires – October 25, 2007

ca_fires_AMO_2007298_EONasagov.jpg

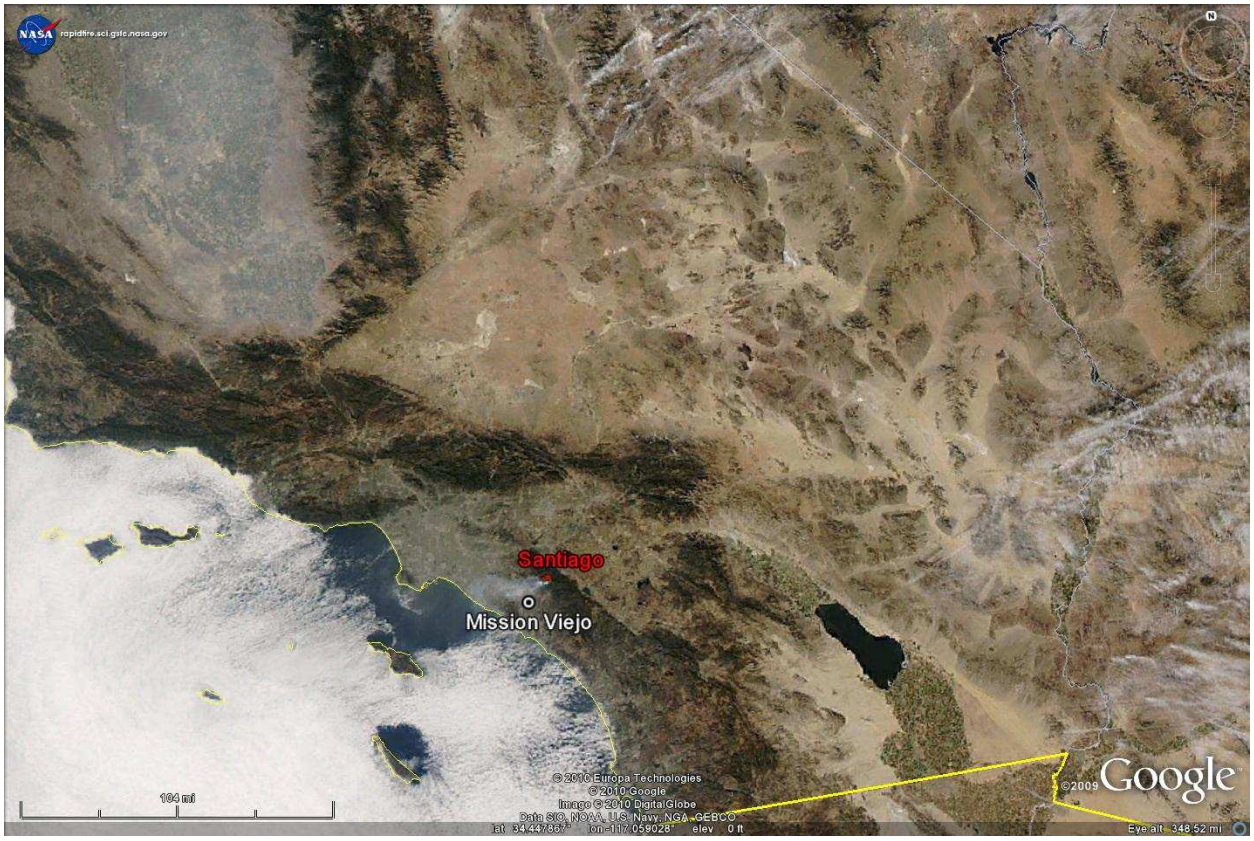
October 26 – November 6. For the remainder of October and into the early part of November, fires continued to smolder and smoke to linger (Figure 26), continuing to impact several monitoring sites. An upper level low pressure system developed off the central coast of California, pulling moist, tropical air into the inland region and bringing with it clouds and slightly cooler temperatures. The presence of clouds limited direct satellite analysis of smoke plumes, although edges of the smoke "cloud" could still seen and analysis showed that it had moved into large areas of Nevada and Arizona (Appendix F). The further development of a weak surface trough over California allowed onshore flow to persist, keeping the Southern California region subject to lingering smoke.

Figure 26. NOAA Satellite Fire Detection Smoke Analysis Product
October 26, 2007



The South Coast AQMD continued to issue health and smoke advisories for the lingering smoke, particularly in Orange County, where the Santiago Fire remained uncontained. Figure 27 shows the Santiago Fire in relation to the monitor most affected, Mission Viejo, on November 2. The last of the October 2007 wildfires, the Poomacha Fire in San Diego County, was finally contained (but not extinguished) on November 13.

Figure 27. NOAA Satellite/Google Earth™ Image of California Wildfires – November 2, 2007



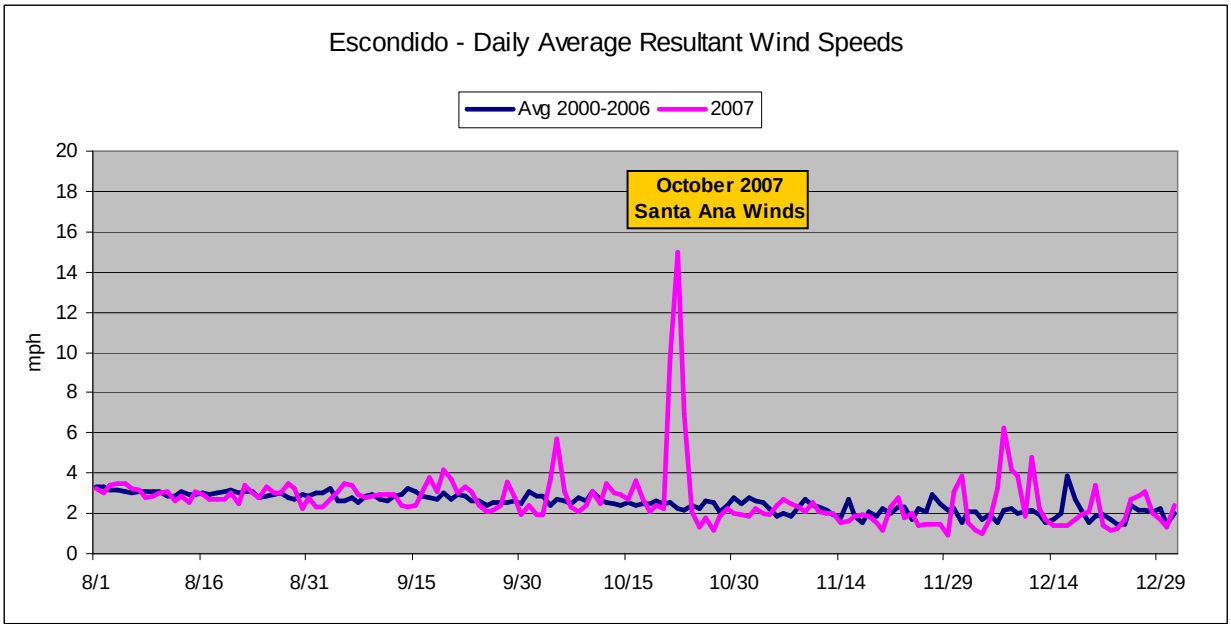
Historical/Background

Climatology/Meteorology

Meteorological and climatological analyses of the time period of the wildfires indicate unusual atmospheric and environmental conditions. The passage of cold fronts over the region is not unusual, but the high winds associated with the cold front of October 20 were. In addition, although Santa Ana wind events are well-known in the region, October 2007 was considered extreme[8] with some areas clocking winds in excess of 100 mph[7]. Coupled with a seasonably dry summer and a drier than normal fall, these intense winds were able to entrain and transport vast amounts of dust, smoke, and ash throughout the region. A National Weather Service compilation of weather events in Southern California[9] noted gusts of 70 mph and higher recorded at Fremont Canyon, San Bernardino, Descanso, Mira Loma, Fallbrook and Rancho Cucamonga with tropical storm force winds experienced in some areas for more than 36 consecutive hours.

Using data from the Escondido monitoring site as a case in point, winds prior to October 20 were fairly typical for the season (Figure 28). The October 2007 Santa Ana Winds were an extreme example of a seasonal phenomenon that exacerbated an already dangerous situation brought on by high temperatures and dry conditions.

Figure 28. Daily Average Resultant Wind Speeds at Escondido.



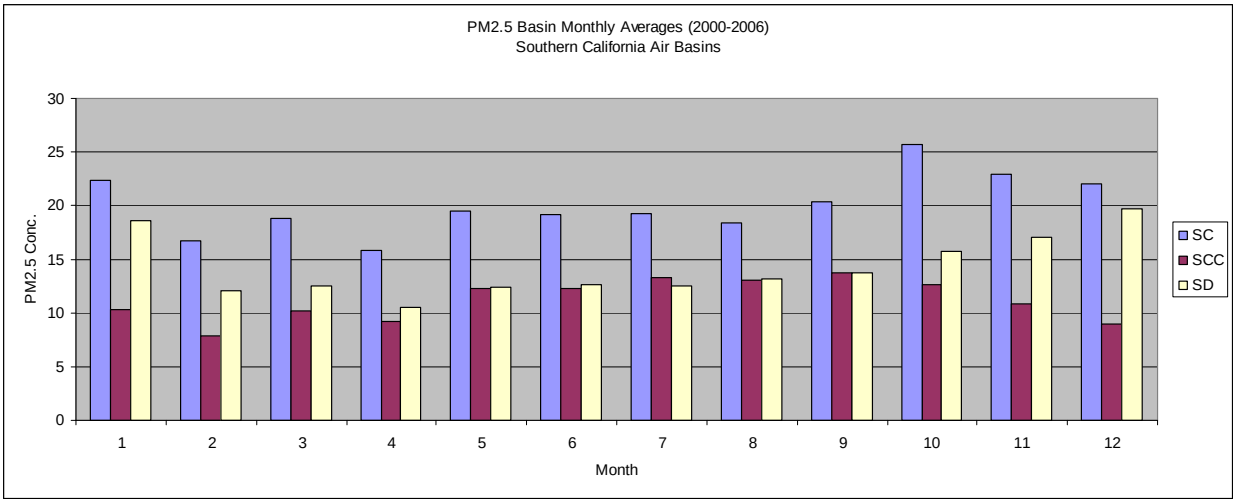
California Wildfires

With numerous individual fires in the region exacerbated by the strong Santa Ana winds, which stymied fire fighter efforts for quick control of the wildfires, October 2007 became one of the most severe wildfire seasons in California history. The Witch Fire, in San Diego County, was the fourth largest fire (by acreage) since 1932[10]. Seven counties were declared eligible for individual federal disaster assistance, with all counties in the State eligible for some assistance under the Hazard Mitigation Grant Program[11].

PM Concentrations

$PM_{2.5}$ concentrations in the South Coast, South Central Coast, and San Diego Air Basins do not show strong seasonal variations (Figure 29). On a monthly average basis, even the high seasons do not historically exceed the 24-hour $PM_{2.5}$ NAAQS of 35 $\mu g/m^3$.

Figure 29. Basin $PM_{2.5}$ Monthly Averages – 2000-2006



PM_{10} concentrations (Figure 30) show highest average concentration levels during the summer months in both the South Coast, South Central Coast, and Mojave Desert Air Basins. The San Diego Air Basin exhibits a slight high season in the fall. None of these monthly averages exceed the 24-hour PM_{10} NAAQS of 150 $\mu g/m^3$.

Figure 30. Basin PM_{10} Monthly Averages – 2000-2006

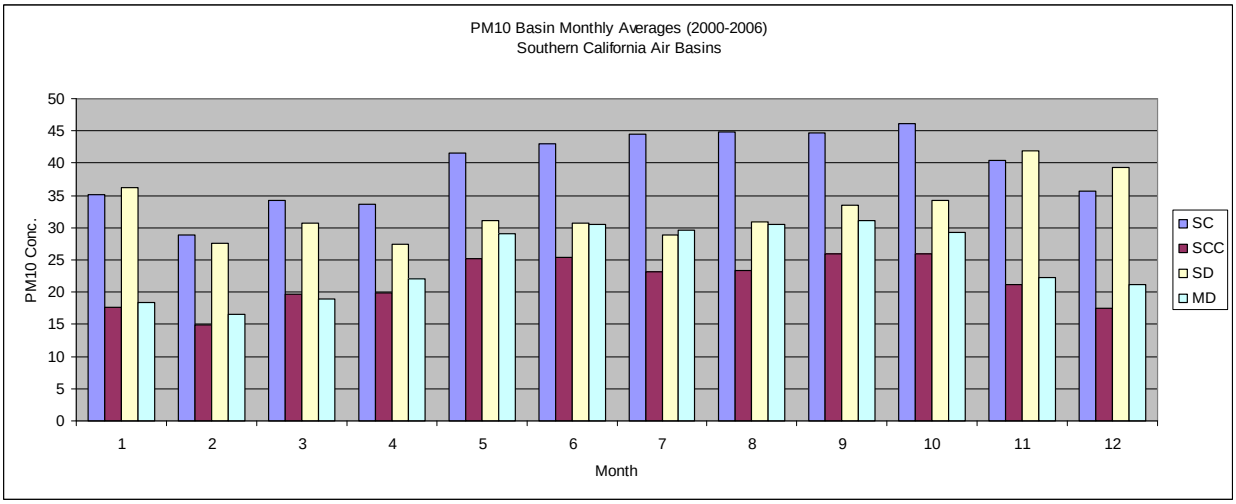
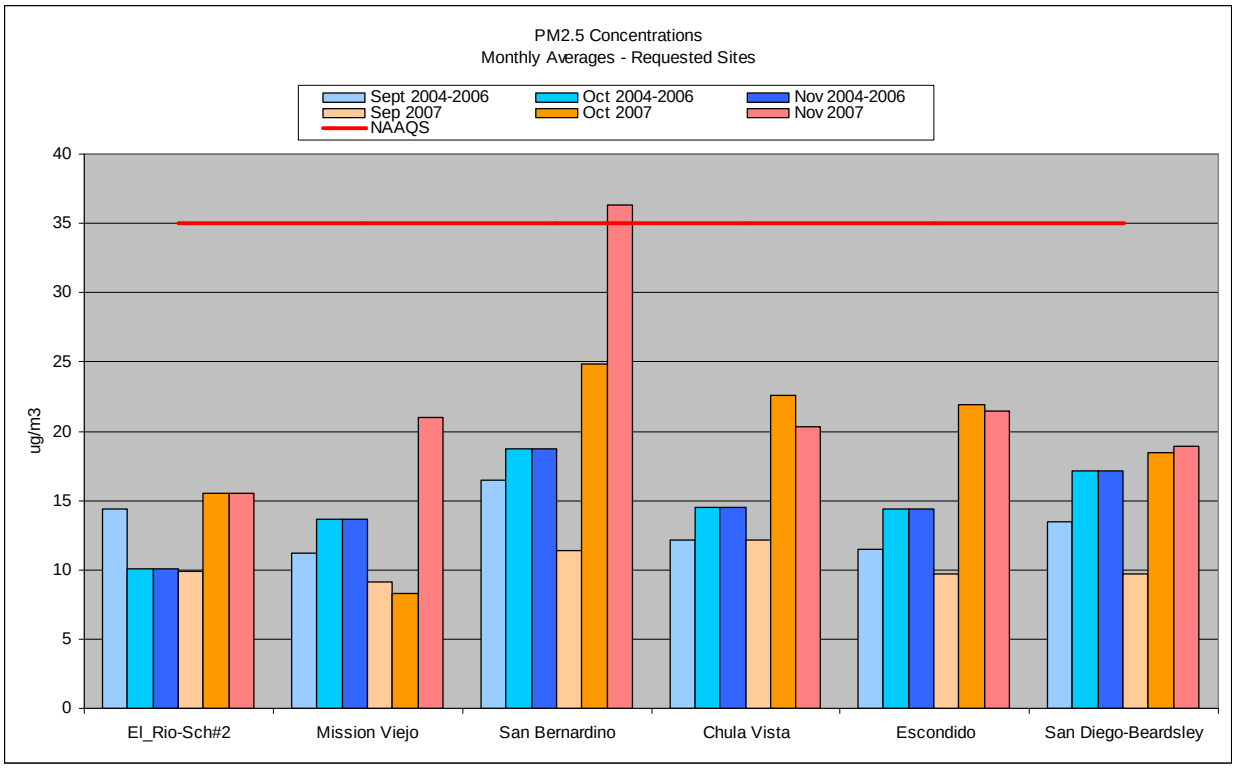


Table 4 shows average fall monthly $PM_{2.5}$ concentrations for those sites for which we are requesting an exceptional event determination. The 2004-2006 fall averages are well below the NAAQS. This tabular data is shown graphically in Figure 31 with blue columns indicating the previous three-year average and the orange columns showing the wildfire impact in 2007.

Table 4. $PM_{2.5}$ Concentration Fall Monthly Averages – 2004-2006 and 2007

Site with Data to be Excluded as Impacted by Exceptional Event			2004-2006 Averages			2007 Averages		
Air District	**Site Name**	**Monitor**	**Sept**	**Oct**	**Nov**	**Sept**	**Oct**	**Nov**
Ventura County (South Central Coast Air Basin)	El Rio – School #2	A	14.4	10.5	10.1	9.8	15.5	15.5
South Coast	Mission Viejo	A	11.2	12.0	13.7	9.1	8.3	21.0
	San Bernardino	A	16.5	20.7	18.8	11.4	24.9	36.3
San Diego	Chula Vista	A	12.2	12.5	14.5	12.2	22.6	20.3
	Escondido	A	11.5	11.7	14.4	9.7	21.9	21.4
	San Diego-Beardsley	A	13.5	14.4	17.1	9.7	18.4	18.9

Figure 31. $PM_{2.5}$ Concentration Fall Monthly Averages at Requested Sites 2004-2006 and 2007.



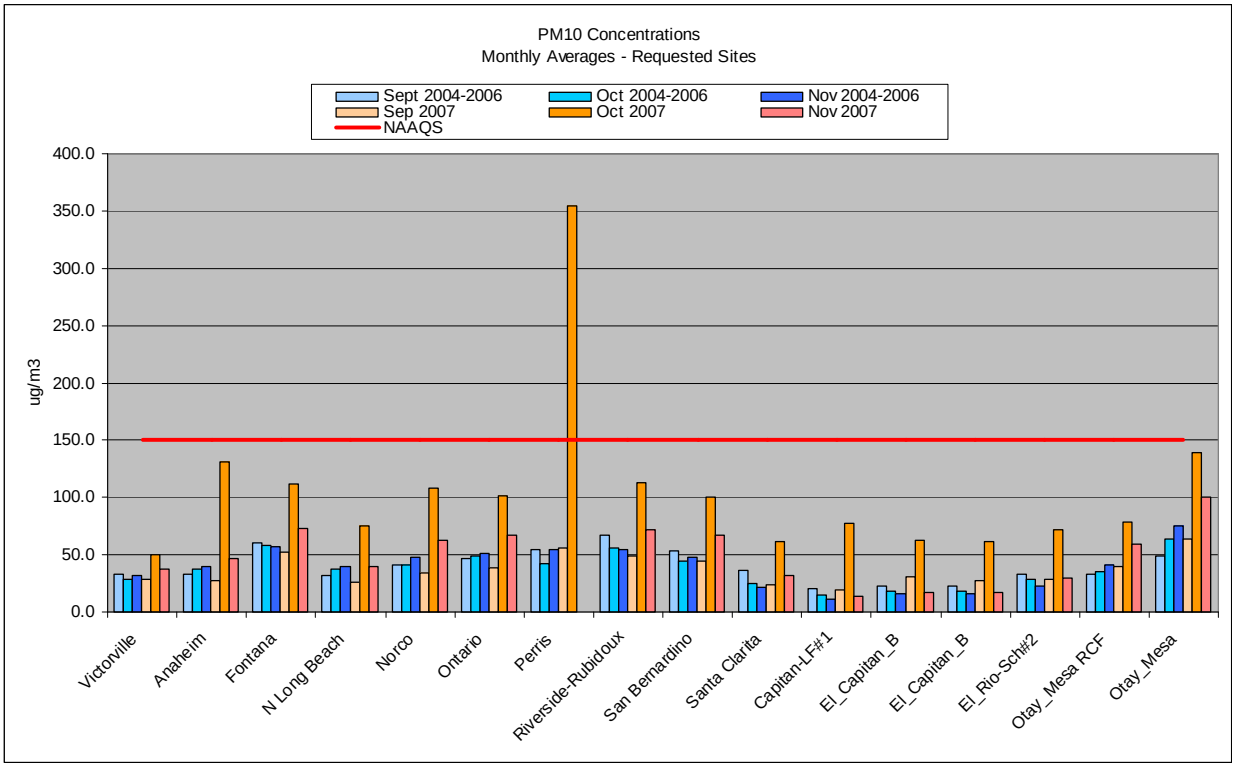
Individual $PM_{2.5}$ concentration frequency histograms, utilizing data from all daily monitors, including non-FRM/FEM, are shown in Appendix B.2. The data requested for exclusion in this document range from the 98th to the 100th percentiles of all concentrations, making them historically significant.

Table 5 shows average fall monthly PM_{10} concentrations for sites for which we are requesting an exceptional event determination. The 2004-2006 fall averages are generally well below the NAAQS. This tabular data is shown graphically in Figure 32 with blue columns indicating the previous three-year average and the orange columns showing the event impact in 2007.

Table 5. PM_{10} Concentration Fall Monthly Averages – 2004-2006 and 2007

Site with Data to be Excluded as Impacted by Exceptional Event			2004-2006 Averages			2007 Averages		
Basin	**Site Name**	**Monitor**	**Sept**	**Oct**	**Nov**	**Sept**	**Oct**	**Nov**
Mojave Desert	Victorville-Park	B	33.6	28.6	31.9	28.2	50.2	37.5
South Coast	Anaheim	A	33.5	37.9	40.4	27.0	131.6	47.2
	Fontana	A	60.7	58.1	56.8	52.0	112.2	72.5
	N Long Beach	A	32.4	38.1	40.1	26.0	75.6	40.2
	Norco	A	40.9	41.1	48.1	33.8	108.6	63.0
	Ontario	A	46.5	49.3	51.2	38.6	101.4	67.4
	Perris	A	54.1	42.6	55.1	55.6	354.5	n/a
	Riverside-Rubidoux	A	67.5	55.5	55.2	48.9	112.7	71.7
	San Bernardino	A	53.3	44.3	47.6	44.4	100.8	67.8
	Santa Clarita	A	36.9	25.3	22.0	23.6	61.2	32.2
South Central Coast	Capitan-Las Flores Canyon	A	20.0	14.6	11.4	19.4	77.3	13.3
	El Capitan Beach	A	22.9	18.0	15.9	31.0	62.6	16.7
	El Capitan Beach	B	23.1	18.4	15.9	27.5	61.7	17.0
	El Rio	A	33.0	28.9	22.5	28.0	71.9	29.2
San Diego	Otay Mesa RCF	A	33.2	35.8	40.8	40.0	78.4	59.8
	Otay Mesa	A	48.9	64.2	75.2	64.0	139.2	99.8

Figure 32. PM_{10} Concentration Fall Monthly Averages at Requested Sites 2004-2006 and 2007



Individual PM_{10} concentration frequency histograms, utilizing data from all daily monitors, including non-FRM/FEM, are shown in Appendix B.4. The data requested for exclusion in this document are all above the 99th percentile of all concentrations, making them historically significant.

But-For

A conservative estimate of the $PM_{2.5}$ mass contributed by the smoke from the wildfires to the concentrations at the monitoring sites is given in Table 6. Based on data from the previous three-year period, 2004-2006, the range of a normal concentration at the requested sites extends from the lowest seasonal average of 12 μg/m^3 (El Rio and Mission Viejo) to the highest 98th percentile of 44 μg/m^3 (San Bernardino). Following U.S. EPA suggested methodology[12], ARB staff estimates that the wildfire event during the fall of 2007 provided an additional 8 to 113 μg/m^3 to the $PM_{2.5}$ concentrations at the requested sites. 'But-For' the high winds and wildfires, there would have been far fewer exceedances of the federal $PM_{2.5}$ standard or negative impacts on federal design values.

Table 6. Estimate of $PM_{2.5}$ Concentrations 'But-For' the High Winds and Wildfires of October 2007

Basin	Site Name	AQS ID	Monitor	Date	$PM_{2.5}$ Mass	Fall 2004-2006		Contributed by Fire	
						Avg	98th Perc	Lower Limit	Upper Limit
South Central Coast	El Rio – School #2	061113001	A	21-Oct-07	39.9	12	32	8	28
South Coast	Mission Viejo	060592022	A	02-Nov-07	46.8	12	26	21	35
	Mission Viejo	060592022	A	05-Nov-07	35.7	12	26	10	23
	San Bernardino	060719004	A	24-Oct-07	72.1	18	44	28	54
San Diego	Chula Vista	060730001	A	24-Oct-07	77.8	13	30	47	65
	Escondido	060731002	A	22-Oct-07	124	13	30	94	111
	Escondido	060731002	A	23-Oct-07	126.2	13	30	96	113
	Escondido	060731002	A	28-Oct-07	52.7	13	30	23	40
	San Diego-Beardsley	060731010	A	23-Oct-07	40.5	15	30	11	26
	San Diego-Beardsley	060731010	A	24-Oct-07	69.6	15	30	40	55
	San Diego-Beardsley	060731010	A	25-Oct-07	49.3	15	30	20	34

An estimate of the PM_{10} mass contributed by wind-driven dust and ash and smoke from the wildfires to the concentrations at the monitoring sites is given in Table 7. Based on data from the previous three-year period, 2004-2006, the range of a normal concentration at the requested sites extends from the lowest seasonal average of 15 μg/m^3 (Capitan) to the highest 98th percentile of 154 μg/m^3 (Otay Mesa) (The 98th percentile used here is an estimate based on 1-in-6 day sampling.) Following U.S. EPA suggested methodology[12], ARB Staff estimates that the wildfire event during the fall of 2007 provided an additional 87 to 1161 μg/m^3 to PM_{10} concentrations. 'But-For' the extreme winds and the wildfires, there would have been no exceedances of the federal PM_{10} standard.

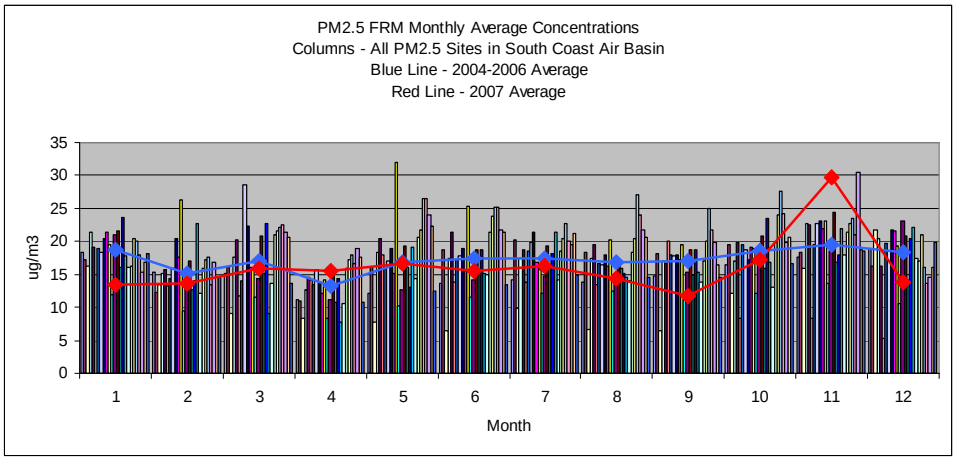
Table 7. Estimate of PM_{10} Concentrations 'But-For' the High Winds and Wildfires of October 2007.

Basin	Short_Name	AQS ID	Monitor	Date	PM_{10} Mass	2004-2006 Fall		Contributed by Fires	
						Avg	98th Perc (est)	Lower Limit	Upper Limit
Mojave Desert	Victorville	060710306	B	20-Oct-07	180	32	61	119	148
South Coast	Anaheim	060590007	A	21-Oct-07	489	37	78	411	452
	Fontana	060712002	A	21-Oct-07	276	59	110	166	217
	N Long Beach	060374002	A	21-Oct-07	232	37	67	165	195
	Norco	060650003	A	21-Oct-07	332	43	77	255	289
	Ontario	060710025	A	21-Oct-07	275	49	78	197	226
	Perris	060656001	A	21-Oct-07	1212	51	105	1107	1161
	Riverside-Rubi	060658001	A	21-Oct-07	559	59	113	446	500
	San Bernardino	060719004	A	21-Oct-07	219	48	84	135	171
	Santa Clarita	060376012	A	21-Oct-07	167	28	46	121	139
South Central Coast	Capitan-Las Flores	060831025	A	21-Oct-07	320.3	15	29	291	305
	El Capitan Beach	060830008	A	21-Oct-07	227.8	19	32	196	208
	El Capitan Beach	060830008	B	21-Oct-07	223.2	19	32	191	204
	El Rio	061113001	A	21-Oct-07	245.5	28	52	194	217
San Diego	Otay Mesa RCF	060731014	A	22-Oct-07	170	37	83	87	133
	Otay Mesa	060732007	A	21-Oct-07	394	61	154	240	333

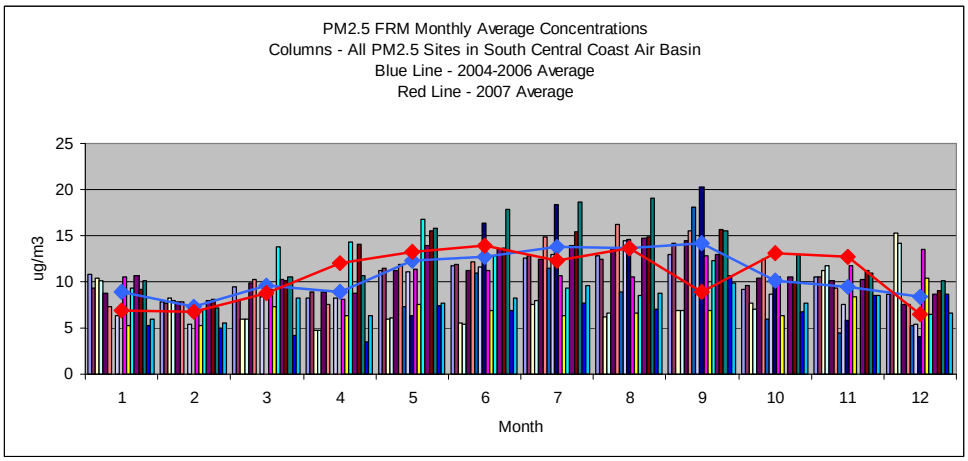
As shown in Figures 33 and 34, without the presence of the wildfires and high winds, and the corresponding increases in PM concentrations, there would have been no exceedances of the federal PM standards. The blue lines indicate the expected average concentration, based on the previous three years' data; the red lines show the 2007 average; the difference shows the impact of the wildfires and high winds.

Figure 33. $PM_{2.5}$ Concentrations 'But-For' the Exceedances of 2007

a. South Coast Air Basin



b. South Central Coast Air Basin



c. San Diego Air Basin

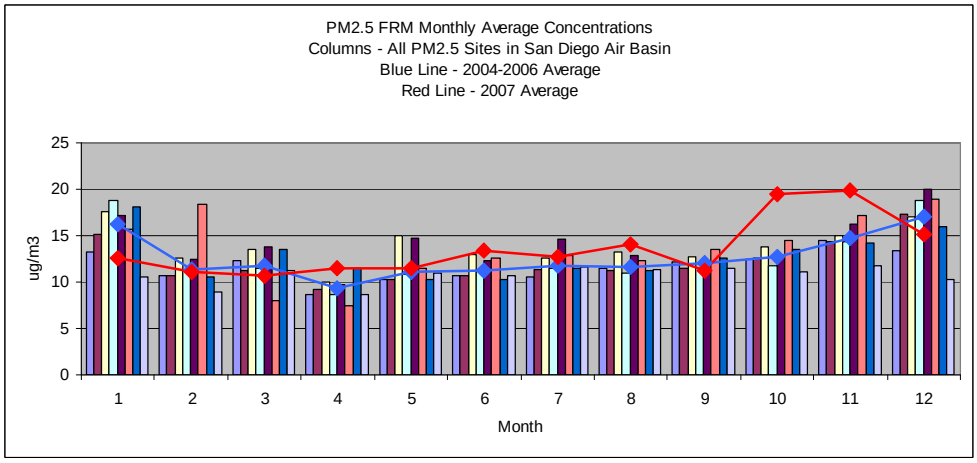
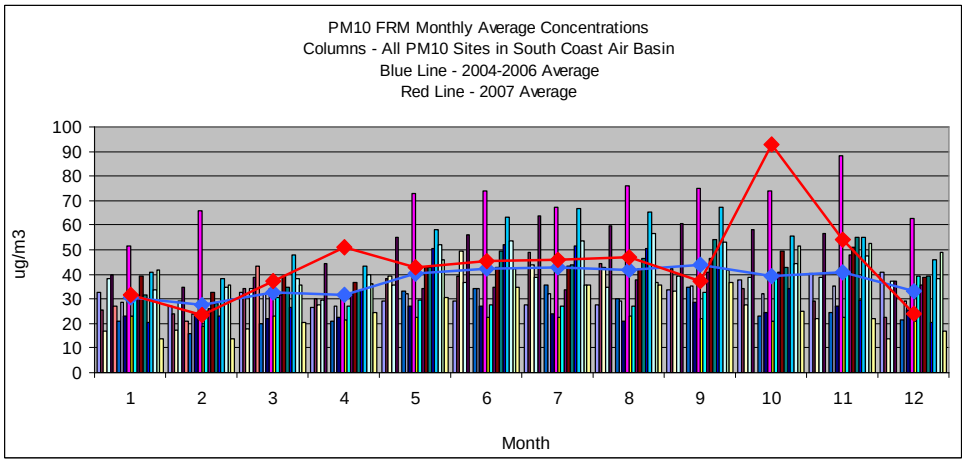
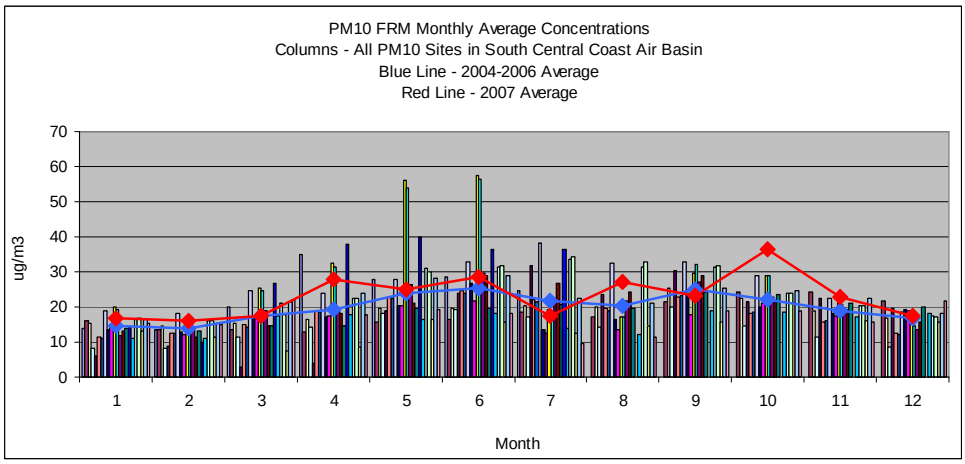


Figure 34. PM_{10} Concentrations at Affected Sites 'But-For' the Exceedances of 2007

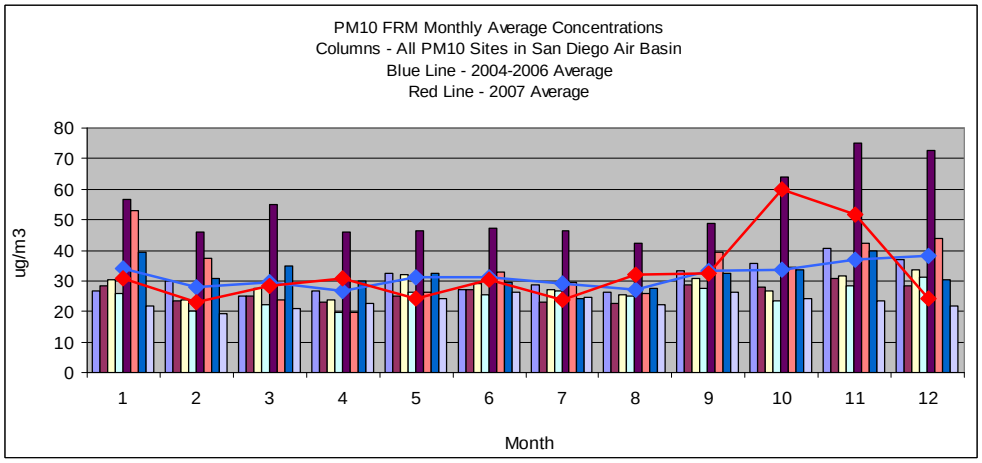
a. South Coast Air Basin



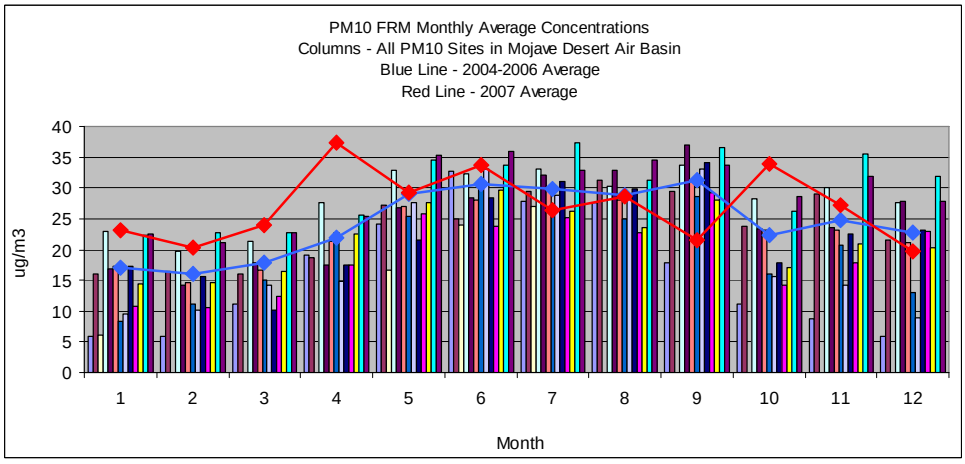
b. South Central Coast Air Basin



c. San Diego Air Basin



d. Mojave Desert Air Basin



Local Emissions

As noted earlier in this document, PM monitoring for the fall of 2007 showed normal concentration levels both before and after the exceedances. There were no unusual local emissions before, during, and after the events. The winds associated with this event were high enough to overwhelm any local controls. In addition, smoke controls were in effect and an agricultural 'No Burn' day was declared from October 21 through early November for the South Coast and the San Diego Air Basins, with the 'No Burn' edict in effect in the San Diego Air Basin until November 15. The majority of these days were also 'no-burn' days in the South Central Coast Air Basin (Appendix B.5).

Mitigation Requirements

Provide for Prompt Public Notification of Exceedance Events

Numerous health and smoke advisories were issued by ARB, the Air Districts, the U.S. Forest Service, the National Parks Service, the California Department of Forestry and Fire Protection, and the State of California. Copies of many of these advisories are included in Appendix G. The National Weather Service issued continuous high wind warnings beginning on October 20. Copies of these advisories are included as part of the South Coast Natural Event Document submitted to the U.S. EPA on July 24, 2009 and included in Appendix I.4 of this document.

Health Advisory Programs exist at all of the Air Districts to promptly notify the public, via website postings, news media releases, faxes, e-mail, and phone text messages, of unhealthy air quality events when data indicate the likelihood of air pollutant concentrations reaching the Unhealthy for Sensitive Groups range or exceeding the NAAQS. Numerous agencies (including the Air Districts and ARB) operate $PM_{2.5}$ BAM sites (both permanent and temporary) for forecasting purposes. This data is used to keep the public informed of current air quality conditions, and much of it is posted to the Internet via the ARB's website at: http://www.arb.ca.gov/aqmis2/aqmis2.php. In the case of any smoke incursion, ARB and the Air Districts work in cooperation with local health agencies, media, and other entities to provide timely information to the public on the health hazards of smoke and ways to minimize health impacts.

Provide for Public Education on How to Minimize Exposure

ARB, the Air Districts, the U.S. Forest Service, the National Park Service, the California Department of Forestry and Fire Protection, and the State of California, all have active community outreach programs, as well as easily accessible information on numerous websites, to aid in public education on the hazards posed by smoke from wildfires and how to minimize exposure. For example, ARB has published, "Wildfire Smoke: A Guide for Public Health Officials", readily available as hard-copy or on-line, to aid local officials, as well as the general public, in understanding the health impacts of wildfire smoke[13]. In addition, the California Air Pollution Control Officers' Association (CAPCOA) Public Outreach Committee, comprised of representatives of all the California Air Districts, maintains an up-to-date webpage to consolidate and disseminate consistent information on the impact of smoke on public health[14].

Summary

This report documents that the event met the criteria stated earlier and provides analysis to demonstrate that:

I. The events were not reasonably controllable or preventable because the smoke and dust originated from a non-anthropogenic source;

Numerous wildfires, with associated smoke, impacted the monitoring sites throughout Southern California, and were exacerbated by extreme winds, which also entrained and transported dust and ash. Most of the wildfires were contained by the end of October, although some remained out-of-control until mid-November. Wildfire impacts were experienced over a vast area, encompassing the entire southern portion of the State of California and portions of neighboring states as detailed in numerous news reports (Appendix H) as well as in the NOAA Smoke Text Products (Appendix F).

II. There is a clear-causal connection between the wildfires and the high winds and the exceedances at the monitoring sites.

The impacts from the wildfires and high winds were seen on both satellite images and on-the-ground reports of smoke and dust. Although detailed speciation data is not available for all sites, those sites that did report carbon data showed a marked increase in organic carbon concentrations, indicating a high smoke impact. A clear-causal connection, therefore, exists between the wildfires and high winds and the rising PM levels seen at the monitoring sites.

III. The measured concentrations were beyond normal historical levels;

The average PM mass concentrations for the requested sites, without impacts from the wildfires and high winds, were below the NAAQS. The measured concentrations during the events reached up to twenty times expected levels, making the PM concentrations historically significant.

IV. The exceedances would not have occurred "but for" the smoke from the wildfires and dust entrained and transported by the high winds.

PM concentration levels at the affected sites before October 20 were close to expected levels for the fall season. 'But-for' the contribution of the high winds and wildfires, PM levels would have been below the NAAQS.

In conclusion, the rise in $PM_{2.5}$ concentrations at the affected sites, in close proximity to the extensive wildfires, and further implicated by satellite images, ground-level observations, and news media reports, indicate a clear and causal connection between the wildfires and the exceedances at the monitors. Further analysis of historical and background levels, as well as local emissions, indicates that 'but-for' the high winds and wildfires, there would not have been exceedances at the affected monitors.

Furthermore, the rise in PM_{10} concentrations at many monitoring sites, in conjunction with the extreme high winds which entrained and transported dust, and further implicated by satellite images, ground-level observations, and news media reports, indicate a clear and causal connection between the high winds and the exceedances at the monitors. Further analysis of historical and background levels, as well as local emissions, indicates that 'but-for' the high winds, there would not have been exceedances at the affected monitors.

List of Appendices

A. Monitoring Sites and Days Requested for Exclusion
B. Air Quality Data and Statistics
C. Meteorological Charts and Data
D. Fire Information
E. Satellite Imagery
F. NOAA Satellite Services, Smoke Detection
G. Government Notices, Proclamations, and Advisories
H. News and Media Coverage
I. Supplemental Materials

References

1. Durkee, K.R., and S. Cohanim. South Coast Air Quality Management District. *Analysis of Exceptional Events Contribution to High PM10 Concentrations in the South Coast Air Basin on October 21, 2007*. [www.aqmd.gov/pub_edu/pdf/EE20071021.pdf]. Last accessed 6/21/10.

2. Federal Register (72 FR 13560-13581). *Treatment of Data Influenced by Exceptional Events; Final Rule*. Vol.72, No. 55, Pages 13560-13581, March 22, 2007,

3. National Oceanic and Atmospheric Administration (NOAA). MODIS Rapid Response System. *Frequently Asked Questions*. [rapidfire.sci.gsfc.nasa.gov/faq/]. 2009

4. Berlant, Daniel. *Fire Siege*. Communique, CalFIRE, Spring 2008

5. State of California. Department of Forestry and Fire Protection. *California Fire Siege 2007: An Overview*. [www.fire.ca.gov/fire_protection/downloads/siege/ 2007/Overview_CompleteFinal.pdf]. Last accessed 5/6/10

6. State of California. Office of Emergency Services. SoCal 2007. *Fire Summary*. [www.oes.ca.gov/Operational/OESHome.nsf/PDF/Fire%20PDFs%202007/$file/FireSummary.pdf], 2010

7. Nielson, John. "*Fabled Santa Ana Winds Fuel Wildfires in California*". National Public Radio, October 24, 2007. [www.npr.org/templates/story/story.php?storyId=15584420] Last accessed 6/7/2010.

8. Grumm, Richard H. *Santa Ana Winds and Anomalies to Forecast Them*. Pennsylvania State University Weather Case Studies 2007-10-26. [nws.met.psu.edu/severe/2007/index.html]. Last accessed 6/7/10.

9. National Weather Service. *A History of Significant Weather Events of Southern California*. Updated February 2010. [www.wrh.noaa.gov/sgx/document/weatherhistory.pdf]. Last Accessed 6/7/10.

10. State of California. Department of Forestry and Fire Protection. *20 Largest California Wildfires*. [www.fire.ca.gov/communications/downloads/fact_sheets/20LACRES.pdf]. Last accessed 6/21/10.

11. Federal Register (72 FR 62251-62252). Federal Emergency Management Agency. *California; Major Disaster and Related Determination*. Vol. 72, No. 212, Pages 62251-62252, November 2, 2007.

12. United States Environmental Protection Agency (U.S. EPA), Neil Frank, *Presenting Evidence to Justify Data Exclusion as an Exceptional Event*, Presentation to Westar State/EPA Exceptional Events Implementation Meeting, February 25-26, 2009.

13. California Air Resources Board (ARB). Smoke Management Program. *Wildfire Smoke: A Guide for Public Health Officials* [www.arb.ca.gov/smp/progdevpubeduc/wfgv8.pdf], Rev. July 2008.

14. California Air Pollution Control Officers' Association (CAPCOA). *Smoke Impact*. [www.airquality.org/smokeimpact/], 2009

Other Resources

California Air Resources Board (CARB). Air Quality and Meteorological Information System (AQMIS2). [www.arb.ca.gov/aqmis2/aqinfo.php], 2010

California Air Resources Board (CARB). California Ambient Air Quality Data (1980-2008). 2010 Air Quality Data DVD, April 2010

County of San Diego. San Diego County 2007 Firestorms After Action Report and Appendices. February 2008. Wild Land Fire Facts and Preparedness. [www.co.san-diego.ca.us/oes/disaster_preparedness/oes_jl_wildland_fire.html]. 2010

Federal Emergency Management Agency (FEMA). California Wildfires. [www.fema.gov/news/event.fema?id=9029], 2010.

National Aeronautics and Space Administration (NASA). MODIS Rapid Response System. NASA/GSFC, MODIS Rapid Response. [rapidfire.sci.gsfc.nasa.gov/]. 2010

National Oceanic and Atmospheric Administration (NOAA). Air Resources Laboratory, Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT): [www.arl.noaa.gov/HYSPLIT.php], 2010

National Oceanic and Atmospheric Administration (NOAA). Satellite Services Division, Smoke Text Product: [www.ssd.noaa.gov/ps/fire/data/smoke], 2010

National Oceanic and Atmospheric Administration (NOAA). Satellite and Information Service, National Environmental Satellite, Data, and Information Service (NESDIS) Satellite Fire Detections: [map.ngdc.noaa.gov/website/firedetects/viewer.htm], 2010

National Oceanic and Atmospheric Administration (NOAA). Satellite and Information Service, National Environmental Satellite, Data, and Information Service (NESDIS), National Climate Data Center (NCDC). Storm Events Database. [www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms], 2010.

National Oceanic and Atmospheric Administration (NOAA). Storm Prediction Center, Fire Weather Forecast Archives: [www.spc.noaa.gov/products/fire_wx/], 2010

National Oceanic and Atmospheric Administration (NOAA). National Centers for Environmental Prediction. Hydrometeorological Prediction Center. Daily Weather Maps. [www.hpc.ncep.noaa.gov/dailywxmap/index.html], 2010

Raphael, M.N., 2003 The Santa Ana Winds of California. *Earth Interactions*, **7**, 7-008,. [EarthInteractions.org.]

Weather Underground. Weather History [www.wunderground.com/history/], 2009-2010

Internet Sites Detailing the Exceptional Event
(These sites active as of time of submission of this document)

California Digital Library.
2007 Southern California Wildfires Web Archive
http://webarchives.cdlib.org/a/calfires

Cooperative Institute for Meteorological Satellite Studies (CIMSS) Satellite Blog.
California fires: a “smoke signal” in the water vapor imagery?
http://cimss.ssec.wisc.edu/goes/blog/archives/561. Last accessed: 4/26/10.

Google Earth Blog
California Wildfires, Satellite Photos
http://www.gearthblog.com/blog/archives/2007/10/california_fires_satellite_photos_f.html
California Fires Master Layer
http://www.gearthblog.com/blog/archives/2007/10/google_california_fire_master_layer.html
Lat Long Blog Master Layer
http://google-latlong.blogspot.com/2007/10/master-layer-for-southern-california.html

National Geographic News
California Fires Rage, Visible From Space.
http://news.nationalgeographic.com/news/2007/10/photogalleries/wildfire-pictures/

National Aeronautics and Space Administration (NASA).
Earth Observatory. Fires in Southern California.
http://earthobservatory.nasa.gov/NaturalHazards/quarterly.php?cat_id=8&y=2007&q=4

Images of California Wildfires
http://www.nasa.gov/vision/earth/lookingatearth/socal_wildfires_oct07.html

National Oceanic and Atmospheric Administration (NOAA).
Operational Significant Event Imagery.
http://www.osei.noaa.gov/Events/Fires/US_California/2007/

Satellites and Information. STAR – Center for Satellite Applications and Research – Air Quality Remote Sensing Program. Near Real-Time Monitoring of Smoke Plumes from the October 2007 California Fires by NOAA GOES Imager.
http://www.star.nesdis.noaa.gov/star/AQ_index.php. Last accessed: 4/26/10.

Newseum – Interactive Museum and Archive of Newspaper Front Pages
Wednesday, October 24, 2007.
http://www.newseum.org/todaysfrontpages/default_archive.asp?fpArchive=102407

San Diego State University, Department of Geography.
Web Mapping Service for San Diego 2007 Wildfires.
http://map.sdsu.edu/

Science Daily
NASA Satellite Images Show Rapid Growth of California Wildfires
http://www.sciencedaily.com/releases/2007/10/071022202629.htm

United States Government. USA.gov
California Fires – Government Information and Assistance
http://www.usa.gov/californiafires.shtml

University of Maryland, Baltimore County.
U.S. Air Quality Website.
http://alg.umbc.edu/usaq/archives/2007_10.html
http://alg.umbc.edu/usaq/archives/2007_11html

Wikipedia, the free encyclopedia.
October 2007 California wildfires.
http://en.wikipedia.org/wiki/October_2007_California_wildfires